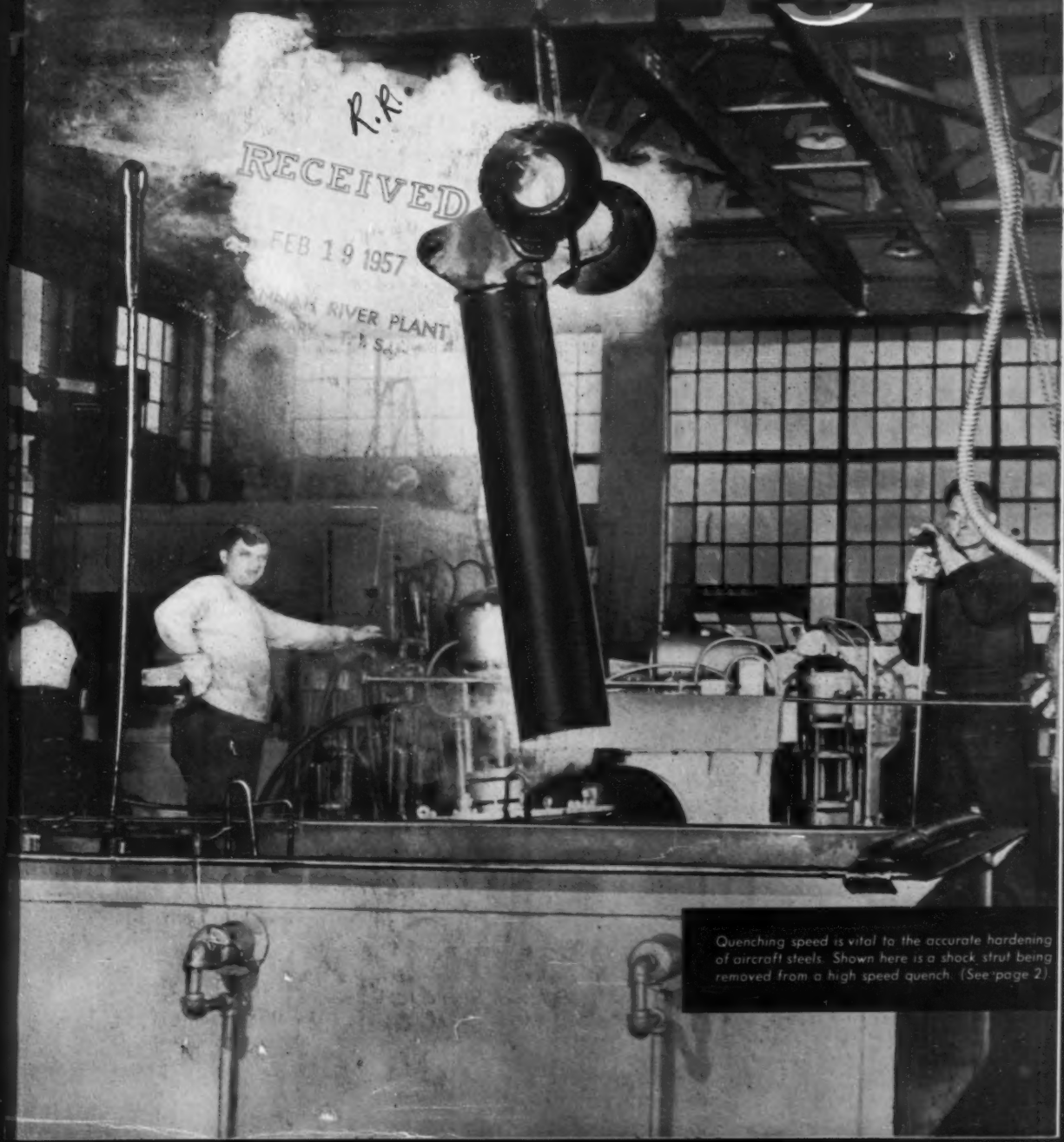
January-February 1957

Metal Treating

THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY



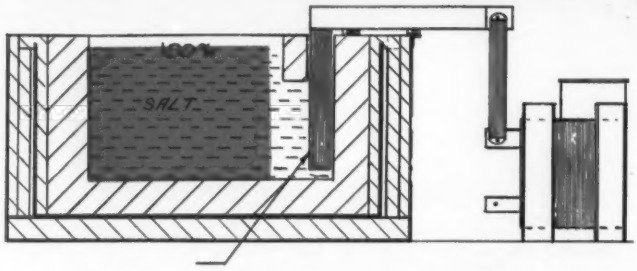
Quenching speed is vital to the accurate hardening of aircraft steels. Shown here is a shock strut being removed from a high speed quench. (See page 2)

HOLDEN
METALLURGICAL PRODUCTS

TRADE MARK REGISTERED

are money mak-ers for Industry

HOLDEN SALT-BATH FURNACES type 701



Holden removable submerged electrodes

1 . . . 100% working area —Length—Width Depth

2 . . . 4 electrodes can be changed in 10 min.

3 . . . Electrodes recessed 4½" away from work load

HOLDEN PAT. NO. 2,701,269

JOIN the PARADE

Profit by

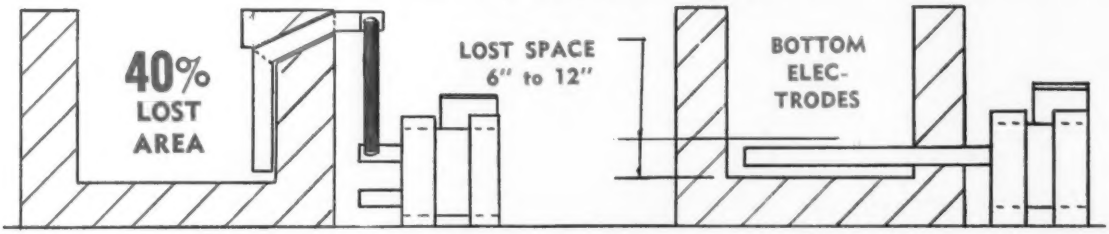
Cooperative Engineering

Replace outmoded furnaces

Why use obsolete designs or copies?

Buy a HOLDEN type furnace assembly!

TYPICAL OUTMODED FURNACES



write for new HOLDEN literature . . . FREE ! . . .

200—Holden Salt Baths
201—Holden Pot Furnaces
203—Rubber Mold Cleaning, Paint Removal, Descaling & Desanding
204—Pressure Nitriding
205—Industrial Furnaces
206—Austempering-Martempering
207—NEW—Recirculation Radiovection Furnace . . . 300° to 1750° F.

We will accept payment from Electrical and Maintenance Savings

THE A. F. HOLDEN COMPANY

Three F.O.B. Points—Los Angeles, Detroit and New Haven

P. O. Box 1898
New Haven 8, Conn.

14341 Schaefer Highway
Detroit 27, Michigan

4700 East 48th St.
Los Angeles 58, Calif.

METAL TREATING INSTITUTE

Vol. VIII No. 1

January-February

★ ★ ★

Editor, C. E. HERINGTON
Asst. Editor, Bus. Mgr.,
H. R. HERINGTON

Published by the Metal Treating Institute, 271 North Avenue, New Rochelle, N. Y. Phone NE 6-4658.

Indexed in Engineering Index

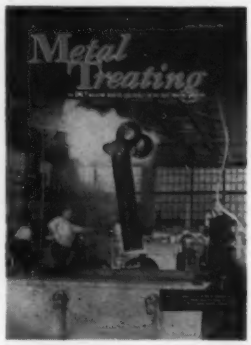
BPA

Member of Business Publications Audit of Circulation Inc.

EDITORIAL

ATTENTION!

Did you notice the new cover on this issue of METAL TREATING? In case you didn't, we are reproducing it here to call it to your attention for a very special reason.



This issue marks the beginning of a new publishing year in the history of this publication. With each passing year since its birth in 1950, we have endeavored to make METAL TREATING a vital factor in a vital industry, and our objective has been to serve that industry effectively.

Our new cover is another way in which we hope to be of service. Good pictures convey ideas as well as words do, and so each issue will feature a large photograph of some important equipment or process or development pertaining to the heat treating industry. This is where you, our readers, can play an important part.

REWARD!

We are offering a reward of twenty dollars ($20.00) for any suitable photograph submitted to us and which we use on the cover. The picture should be an 8½" by 11" glossy photograph and showing a vertical view. In this way we hope to expand our service by keeping our readers abreast of the latest developments in the heat treating industry both editorially and pictorially.

Get out your camera—or dig through your files. It's a sure bet that you can take or already have a "reward"-winning picture. Send one in and see.

C. E. Herington

CONTENTS

Today's Quenching Needs—and How to Meet Them
by S. J. Barber 2

Processes and Techniques for Achieving Extreme Surface Hardness and Wear Resistance
by Frank J. Rizzo 8

Carburizing of Truck Transmission Parts Speeded With New "Mass Marquenching" Setup
by E. A. Schoefer 10

Right or Wrong in Labor Relations 12
News to Heat Treaters 14
Heat Treating Hints 16
The Apprentice Corner 20
M. T. I. Activities 34
Letters to the Editor 37
Abstracts 44
Manufacturers' Literature 46
Equipment & Materials Directory 51
Index to Advertisers 52

TODAY'S QUENCHING NEEDS
....and how to meet them

By **S. J. Barber,** *Manager, Metal Working Dept.*
E. F. Houghton & Co.
Philadelphia, Pa.

IN a discussion of modern quenching practices it would seem necessary at the outset to define what quenching is and what it does to steel, even at the risk of appearing somewhat elemental.

Despite the advances in heat treating in the past fifteen years, perhaps no better definition has been given of this final important step in the process than that written by the late George W. Pressell* way back when grain size and hardenability were but dreams of a few metallurgists. Mr. Pressell, a practical metallurgist and inventor of the first treated quenching oil, explained the quenching action simply in these words:

"Quenching is the procedure of removing heat units from a piece of metal to produce in that metal certain desired physical characteristics which will fit it for its life performance.

"The attainment of these characteristics may be attributed to an *arrested* change in the structure, or in other words, a homogeneous precipitation of the original solid solution of the elements, rather than a precipitation and separation into their normal states."

Since those basic ideas were expressed, many new theories and practices have emerged from the ivory towers and from the practical workshops of the metal industry.

The S-curve was one important step in knowing what happens to various analyses of steel when heat treated. It became known that the quenching time–temperature curve must not pass through the nose of the S-curve, or maximum physicals would not be obtained. That nose has been located for each commercially marketed type of steel.

Grain size control and hardenability ratings progressed from the theoretical to the practical as knowledge of those factors spread rapidly. Steels are now bought on the basis of hardenability bands as well as on physical analysis. Inherent grain size has much to do with the depth of hardening, but the quenching medium also has much more influence than has been credited.

If this discussion can accomplish no more than to stress the importance of that last step in the preparation of a piece of steel for its intended service, then we will have attained much of our objective. Before discussing oils, however, the theory of quenching itself merits brief mention.

* *Formerly Vice President, E. F. Houghton & Co.*

Fig. 1—The mast on this racing schooner was given a uniform quench in a modern high-speed quenching oil.

The medium used for quenching should "favor" the interior structure of the work as well as the exterior, in order to approach the ideal of uniform hardness throughout. In practice this ideal is never fully attained, but the correct quenching medium comes much closer to attainment than the incorrect one.

Water will remove heat at a very fast rate, and has a high penetrative hardening effect. Water is notable for its poor degree of uniformity, the prevalence of soft spots and the necessity of close temperature control.

Brine will remove heat faster and more uniformly than water.

But, water and brine are both too drastic for the sensitivity which the medium and higher carbon steels and alloy steels have. A milder quench must be resorted to, and therefore *oil* must be used.

The three distinct phases of quenching have been previously covered in textbooks and the A.S.M. Handbook. In our own "Practical Metallurgy for Engineers" we differentiate between water, brine and oil quenching in a way that appears easy for the non-metallurgist to understand.

Water Quenching

The first stage of water quenching, it states, is characterized by the formation of a complete vapor envelope about the hot object. Heat transfer is by radiation and conduction through this vapor film and is therefore relatively slow. Secondly, the vapor film collapses and the quenching medium wets out the steel surface, with active boiling taking place. Here the cooling is very rapid.

Heat is carried away by large masses of steam which condense later. When the surface temperature of the immersed work falls below the boiling point of the water, cooling then proceeds by liquid conduction and convection.

Localized persistence of the initial vapor stage causes slow cooling and soft spots—a common difficulty encountered with water quenching. A counter-active measure is to add an inorganic solute to the water. The two most common and effective agents are NaCl and NaOH. They are released from solution during vaporization and destroy the stability of the vapor film, thereby promoting more rapid early cooling.

The real problem arising from water quenching is the generation of high stresses leading to cracking or warpage, depending on the size and shape of the work. We explain this in our own reference book as follows*:

"This is due to the magnitude of the residual stresses remaining in the steel as a result of its martensitic transformation in the presence of a steep thermal gradient during the latter part of the water quench. . . . This tendency of water-quenched steels to crack in certain critical sizes is generally insurmountable, and recourse to oil hardening or air hardening steels is the most economical way out."

Oil Quenching

To obtain full martensitic hardening with a minimum of distortion, oil is used for medium or high alloyed steels. There are also other oil quench assignments: for improving machinability of low carbon steels by providing better grain structure, for stress relieving of plain carbon steels and for obtaining full martensitic hardness in light sections of plain carbon steels.

The initial slow cooling vapor stage in an oil quench lasts longer than in an aqueous quench, but difficulty with soft spot occurrence due to vapor interference is not encountered. In the second stage the relatively low heat vaporization of oils gives a cooling power much lower than in the same phase of a water quench. The oil, however, is mobile as it heats up, and if it possesses extra wetting power, it absorbs and carries away the heat more rapidly, but not at a rate that promotes cracking or warping.

* *"Practical Metallurgy for Engineers", Chapter XI, Page 153, Revised 1952 Edition.*

So much for the difference between oil and water—set down here primarily as a foundation for the discussion of quenching oils to follow.

Oil was adopted as a quenching medium because it produced a better structure, with stresses minimized. However, there is a wide variation in the properties of oils that determine their success for quenching use. These properties include conductivity, boiling point, specific heat, viscosity, wetting power, stability, and finally, quenching speed, which is dependent on a combination of the foregoing factors.

There is more to selection of a quenching oil than specification of physical properties. That is only the beginning. Two other important characteristics must be built into the oil—oxidation stability and quenching speed. Let us look at this from the practical heat treater's standpoint.

It is understandable that a heat treater has quenching problems when you consider all the different alloys he handles, the many shapes and sizes of parts he processes, and the varying conditions in which he receives them. To cope with these complicating variables, it seems logical that he would benefit most from a good all-purpose medium that would successfully and economically meet his full range of requirements for oil quenching.

The importance of the quench. . . that vital last step in the heat treating process. . . cannot be overemphasized. An expensive part, carefully machined and painstakingly heat treated, can be ruined completely at this point because the quench is not right.

Actually, a heat treater has nothing to gain by

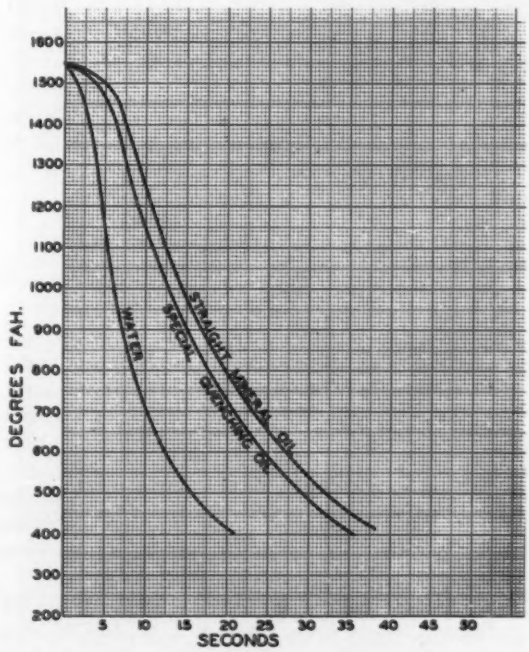


Fig. 2—Chart shows quenching speed of water, special quenching oil and straight mineral oil.

taking any chances on his quenching medium. Consider the investment in equipment alone. The average installation has a good deal of money tied up in its furnace and controlled atmosphere equipment, or salt baths to prevent scaling and decarburization.

Most operations have expensive temperature measuring and controlling units to supply accurate and precise heat treating temperatures. Many have circulation and cooling systems installed to maintain uniform conditions in the quenching bath.

Fig. 3—A tribute to the long life expectancy of a good high-speed quenching oil with built-in stability is this tank containing a fortified quenching oil. It was used for 32 years until, in 1948, a flood washed it out.

Sometimes, after all of these expensive precautions are taken to enable precision heat treating, the desired results are not obtained simply because the oil is inadequate. Quenching oils may appear satisfactory under ideal conditions when they are new. However, they may tend to lose a portion of their quenching speed after a period of use because of oxidation, sludging or the selective absorption and carry-off of the quenching speed additives on the surface of the quenched work.

Ideal Quenching Oil

Therefore, it is to the heat treater's best interest that he use a quenching oil that will not change in quenching characteristics over a wide range of conditions including variations in temperature and circulation. The ideal oil should provide the same uniform results year after year. The bath should require no additions of oil other than that needed to make up for drag-out losses.

A wide reserve of quenching speed should always be available to compensate for the many variable factors which are present from time to time in even the most efficient heat treating operations.

Variations will always occur in the hardenabilities of different lots of steels. Changes in production may require the hardening of heavier sections. Surface finishes of the heat treated parts may be changed because of manufacturing practices. With all of these variables, it definitely pays to use a quenching oil with an extra safety factor.

Experience has shown that straight mineral oils are not the answer to the heat treater's day-to-day needs. Even though they may be suitable for a small percentage of the quenching applications, the average department has such a variety of work running through it that a specially built oil medium provides a needed insurance.

Mineral Oils

Straight mineral oils used for quenching are of average run of the refinery, produced without particular reference to light and heavy ends and sludges. Therefore, they give no guarantee of uniformity of results under varying conditions and prolonged use.

When a hot piece is quenched in a straight mineral oil, some of the ingredients are "cracked" or distilled off, leaving the heavier portions, some portion of which will eventually result in sludge. When these untreated refinery oils are used continually, they tend to thicken and form vapor pockets of low thermal conductivity on the surface of the metal. Cooling is retarded, carry-away losses are increased and the operation becomes more ineffective as use continues.

The range of hardenabilities in certain grades of

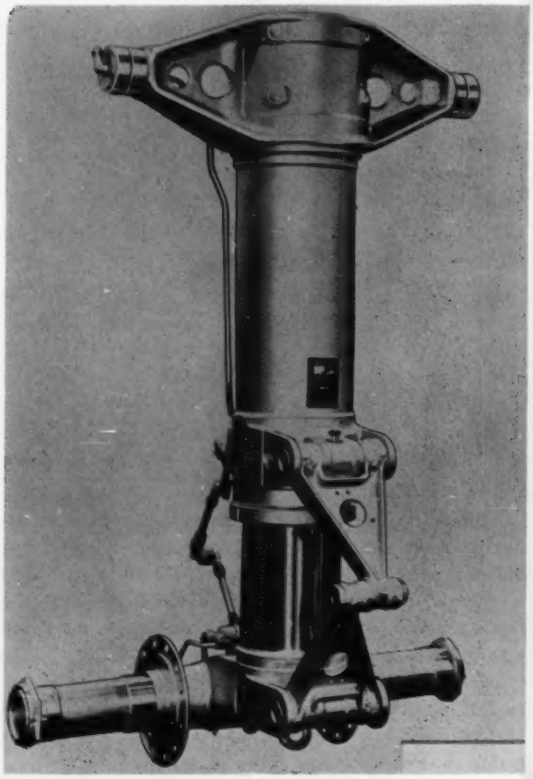


Fig. 4—Aircraft landing gear quenched in super-fast quenching oil (Houghto-Quench "K"). The heat treating department of this company obtained highly satisfactory, uniform quenching results.

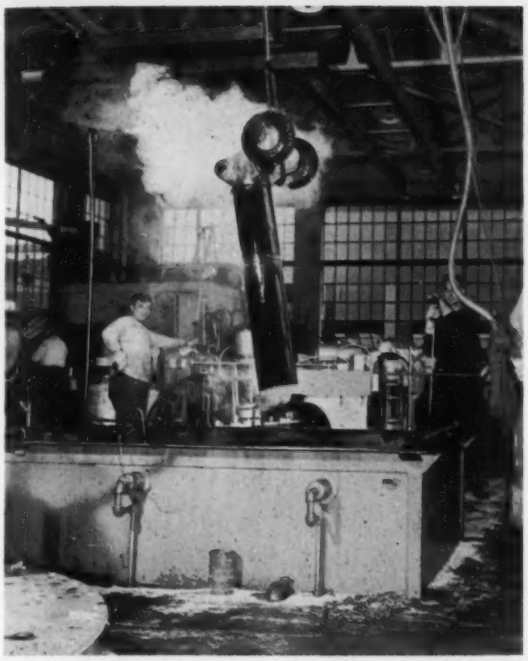


Fig. 5—Quenching of aircraft parts in high speed quenching oil.

steel in combination with heavy sections is such that there may be difficulty in consistently producing the required physical properties with a straight 100-second viscosity mineral quenching oil. This is especially so when the alloying ingredients and the carbon content of the steels are at the low limits of the specification.

Such a condition is likely to occur when the sludge deposits reduce the heat exchanger efficiency of the straight mineral oil, causing the temperature of the oil to rise above 160°F.

Many factors can adversely affect the uniform results expected of a straight run 100-viscosity mineral oil, even when it is new. There can be:

1. Possible variations in the basic hardenability of the steels being quenched.
2. Differences in the surface finishes of the quenched part.
3. Presence of differences in the amount or type of scale present on the work.
4. Wide variations in the diameter, size or cross sections of the work being quenched.
5. Variations in quenching oil temperature.
6. A reduced or non-uniform circulation of the quenching oil.
7. A slight amount of partial surface decarburization present on the parts being quenched.

After the oil has been used and has started to thicken, any one of the above conditions can result in completely unsatisfactory quenching results.

Cost Factors

In addition, there is also false economy in the use of a straight mineral quenching oil. Regardless of the low initial cost, the user is actually paying as much or more than he would for a fortified, high speed oil. And this is without obtaining any of the resulting benefits or improvements in quenching uniformity supplied by these new, improved oils.

Actual cases have shown that in most heat treating operations, consumption of the treated oils has been less than one-half that of the untreated mineral oils. For example, records over a period of years on the quenching of high explosive shells showed that consumption of a high speed type quenching oil ranged from one quart to one-half gallon per ton of steel quenched.

With straight 100-second viscosity mineral oils, the consumption ranges from one gallon per ton when the oil is new, up to two gallons or more after the oil has been in use for some time.

Also consider as a cost factor the excessive sludging, thickening and non-uniform results obtained with a straight mineral quenching oil. These condtions demand periodic replacement of the entire bath. Furthermore, they keep the costs high for cleaning out oil lines, strainers, filters and cooling systems . . . and for shutting down the equipment to remove such sludge.

Accordingly, the average user of the straight mineral quenching oil may be paying premium price for that oil without obtaining any of the insurance against trouble that comes with the fortified superior oils.

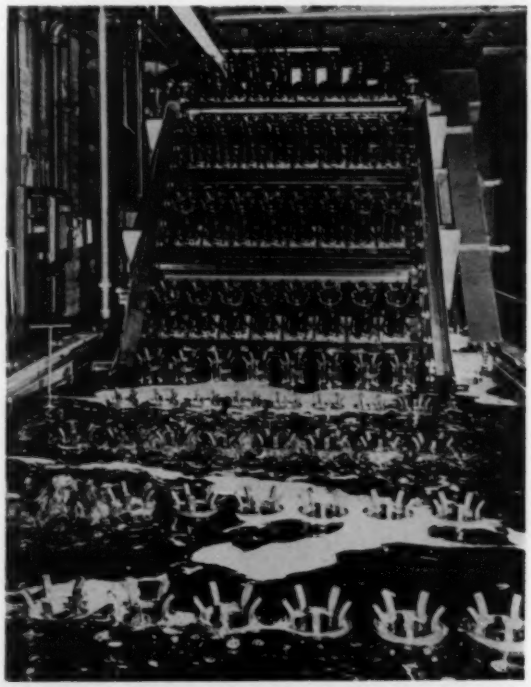


Fig. 6—Rows of shell quenching cages for uniform quenching. Shells are automatically carried up the conveyor discharge for gravity feed to an air draw furnace.

What to Look For

A logical question at this point is "How do you recognize a so-called superior oil?"

Obviously, you have to look for certain properties and characteristics. The ideal all-purpose, high speed quenching oil for general heat treating use should possess the following:

1. A high and uniform rate of cooling in the initial stage of quenching.

Fig. 7—Portable self-contained unit includes quench tank with cooler, pump, strainer and controls. *(Courtesy Bell and Gossett Co.)*

2. A suitable viscosity at the operating temperatures of the quenching oil bath to assure adequate circulation and to reduce the carry-off of oil on the quenched parts.
3. Low volatility under the operating conditions of the quenching oil bath. This reduces the loss of oil from volatilization, and also lowers the fire hazard.
4. High thermal stability to resist the formation of sludge, cracking and oxidation of the oil during extended use in quenching operations.
5. A low rate of heat transfer in the final stage of quenching to minimize cracking and distortion of the quenched steels.
6. Uniformity of hardening over a wide range of conditions.
7. Long life. Quantities of a forerunner product in the high speed series have been in use for more than 30 years with only very slight replenishment.
8. Economical. Most of today's high speed quenching oils will quench more pounds of steel per gallon of oil than mineral quenching oils, and with more uniform results.

High speed, multi-purpose quenching oils are recommended for all types of critical and heavy duty oil quenching applications. In practically every quenching operation, they have been found to substantially increase the cooling rate of the quenched work . . . increase the uniformity of quenched properties beyond expectations . . . reduce the amount of scale on the quenched piece . . . minimize carbonization of the oil . . . and greatly reduce sludging and change in oil properties.

Where precision and uniformity of heat treatment are important, these superior oils have played a vital part in extending the service life of highly stressed parts.

There is one type of operation where an oil with saponifiable content is not recommended—for quenching cyanided work. The saponifiable content is eventually affected by the cyanide which, as an alkali, will saponify that portion of the oil.

The best grades are compounded with oil-soluble synthetic wetting agents which provide rapid wetting-out properties on hot metal surfaces. On quenching, a thin film of oil is rapidly spread over the hot surface of the metal. This film prevents persistence of a gaseous film which would act normally as an insulator against cooling and thus reduce the speed of quenching.

An example of where this quenching speed was invaluable is the hardening of aircraft steels to meet the rigid demands of U. S. Government Specification MIL-H-6875. Because of the strictness of this specification, the matter of quenching speed became imperative for the companies supplying aircraft manufacturers with parts which must have high strength to serve satisfactorily in aircraft.

Relatively few heat treaters have facilities available to make a Jominy End quench test on each separate lot of steel received. So, to offset the possibility of steel being on the lean side of alloy content, the use of a fast quenching oil becomes a necessity.

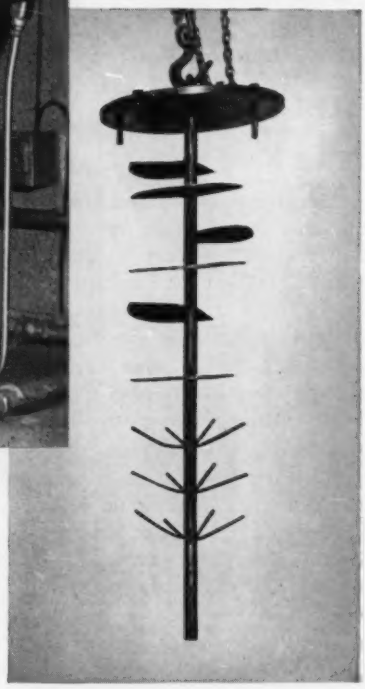
One of the earliest instances in which the high speed oil was given a real production test occurred in the shops of an aircraft landing gear manufacturer. Insufficient hardness in AISI steels 4130, 4140 and 4340 resulted from the use of conventional quenching oils. A change to the super-speed quenching oil resulted in an increased hardness more than enough to meet specification requirements.

Other instances involved use of the super-speed oil with "flamatic hardening" installations where other quenching oils failed to produce the desired hardness. Until a super-speed oil was used, the only means of obtaining such hardness was by use of a water quench. But the hardness benefits of the water quench were offset by distortion and cracking. The super-speed quenching oil gave the maximum benefits of any quenching medium used by eliminating the ill effects of the water quench while producing the required

(Continued on page 28)

Performance is top-notch in Pacific's new vacuum furnace. Inconel alloy retort withstands severe heat-treating conditions, aids operation. Installation shown is at Western Gear Corp., Los Angeles.

Inconel work holding fixture and heat deflecting baffle is lowered into the Inconel retort from above. Inconel alloy lends itself well to the intricate forming and welding called for in making both this fixture and the retort itself.



Inconel retorts help industry explore high vacuums for production heat-treating

What's the best way to prevent brittleness in surface hardening of titanium? Is it practical to finish high alloy parts to tolerance and *then* stress relieve them?

Several concerns are looking into such questions . . . using vacuums up to 0.1 microns.

At Western Gear Corporation the work is done in an interesting new Pacific Scientific Company furnace equipped with an Inconel nickel-chromium alloy retort. The furnace is controlled by instruments and sized for production-run batches. It can be loaded without disturbing vacuum and service connections and back flushed with any desired atmosphere.

Inconel alloy aids operation

Pacific's use of Inconel nickel-chromium alloy aids operation of the furnace in several ways.

First, with wrought Inconel alloy, the retort withstands the severe operating conditions imposed by production research. Long-continued high vacuums at heat don't harm it. Neither do thermal shocks from rapid cooling. Nor corrosive atmospheres.

Second, Inconel simplifies the furnace construction. And its good "hot" strength helps in practical design. What's more, no special work handling fixtures or costly seal constructions are needed. That's because the low coefficient of expansion of Inconel permits retort and furnace to be designed as a single unit.

Third, Inconel can be readily welded to give a strong vacuum-tight joint that stays gas-tight.

More information available

For details concerning this furnace, contact Pacific Scientific Company, Los Angeles, California. For information on the use of Inconel alloy in heat-treating equipment, write Inco for "Keep Operating Cost Down When Temperatures Go Up . . .", a picture-packed Inco booklet. *Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inconel

INCO TRADE MARK **Nickel Alloys**

. . . for long life at high temperatures

PROCESSES AND TECHNIQUES FOR ACHIEVING EXTREME SURFACE HARDNESS AND WEAR RESISTANCE

By **FRANK J. RIZZO,** *President*
Tiarco Corporation
Clark, New Jersey

AS a result of processes and techniques recently developed by the Tiarco Corporation, Clark, N. J., hard, highly ductile chromium plate deposits can now be placed directly upon aluminum. titanium, cold-rolled steels, lead and zinc alloys, tungsten carbide, and beryllium copper.

The Problem

Aluminum and titanium are recognized as workable metals with many industrial applications. They and their alloys have excellent machinability, are lightweight and yet strong, and may be stamped, coined, spun, and cast. However, there are many industrial applications where either function or economy demands that greater wear resistance, greater resistance to oxidation, or a lower coefficient of friction be provided than can be supplied by any known aluminum or titanium alloy.

These demands have been previously met by plating the aluminum or titanium with a surface coating of chromium. But both of these metals are hard to plate because they readily oxidize in air and resist ordinary attempts to create an intermetallic bond. The old conventional method of chrome plating thus necessitated the deposit of successive layers of zinc, copper, and nickel before the chromium could be applied.

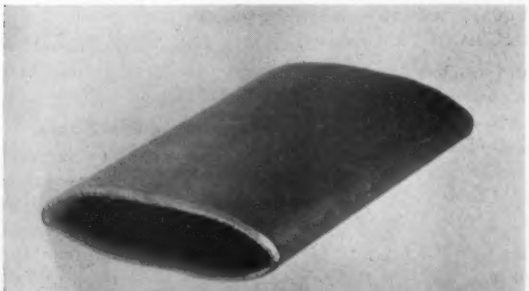


Fig. 1.—Aluminum tubing with a chromium coating 0.014 inches thick that was put in a vise and given rapid pressure to distort it. The chromium did not flake or peel.

Processes Developed

To overcome these obstacles, the Tiarco Corp. has developed processes for depositing a surface layer of hard chromium on various metals.

The Hardalume Process

Where the base metal used is aluminum, the new, unique method is called the Hardalume Process whereby a heavy surface layer of dense and yet ductile chromium is directly adhered to the aluminum without using any other extraneous metals that would form any undesirable electrolytic couples.

One of the main reasons for the success of the Hardalume process is the special method used to prepare the aluminum surface. This preparation consists of a three-stage process of pretreatment: (1) a bath is used to prevent oxidation of the aluminum surface by passivating the metal by excluding air; (2) a bath which reactivates the aluminum while a bonded coating of chromium is applied; and (3) a bath which deposits the hard chromium surface to the desired thickness.

The Baylig Process

Where the base metal used is titanium, the new process is called the Baylig Process whereby chromium is electrodeposited directly on the titanium. As in the process for aluminum, the secret of success lies in the pretreatment of the base metal; and in the Baylig process a two-step operation is used: (1) a thorough mechanical cleaning of the surface of the titanium; and (2) immersion in a special surface-activating bath.

Coating Characteristics

The characteristics of the chromium surface layer, the thickness of the deposit, and its tight adherence to the base metal offer many advantages. The coated metals have been given a series of physical tests to determine the characteristics of the coating.

Fig. 1 shows the coating's ability to withstand a severe and destructive test without peeling or flaking. In this case, a section of 52S aluminum tubing, 3/32 of an inch thick and with an outer diameter of 1½ inches was processed and given a chromium coating of 0.014 inches thick. The end of the tube shown in Fig. 1 was then placed in a vise and rapid pressure was applied in order to distort it. Cracking appeared only because the underlying aluminum cracked, and the chromium did not peel or flake.

Fig. 2 illustrates the highly ductile qualities of the coating and its tight adherence to the base metal. As shown here, a strip of 3S aluminum, ⅛ inch thick was

Fig. 2—This strip of aluminum was given a chromium coating of 0.003 inches thick and then subjected to blows by a chisel and ball hammer. The ductile coating flowed with the aluminum and did not crack, peel or flake.

given a hard chromium surface layer to a thickness of 0.003 inches. Then the coated aluminum was struck with a ¾ inch chisel and the ball end of a hammer to such an extent that the indentations made by the tools were five times greater than the thickness of the chromium layer. This layer was hard, dense and ductile enough to flow with the underlying aluminum, but there were no signs of any peeling, cracking or flaking as shown in Fig. 2. The hardness of the deposit averages Rockwell C72 and in some cases has reached RC80, and the density is about 15% more dense than the conventional hard chromium coatings.

Adherence qualities of the coating on titanium were proved in a test that called for heating a piece of titanium that had been chromium coated to a thickness of over 0.003 of an inch on the side to a temperature of 1600°F. and then quickly quenching the part in cold water. The adhesion was perfect and this test failed to break the metallic bond.

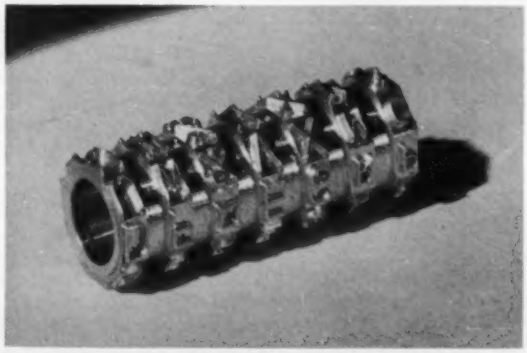


Fig. 3—A chromium coating 0.001 inch was deposited on this aluminum printing plate which is engraved with letters. Clear impressions were maintained after 18,000,000 prints. The old product was made of non-magnetic stainless steel and lost clarity after 8,000,000 impressions.

Another test has proved some of the advantages of chromium coating titanium. A RC-70 titanium strip 1/16 of an inch thick was processed with a chromium layer 0.002 inches thick. This titanium-chromium composite was then subjected to a high energy impact load that involved high magnitude shearing and compressive and tensile stresses by being struck with a prick punch sufficiently hard enough to drive right through the sheet. The chromium surface layer conformed with the underlying titanium in the area of distortion and no chipping or peeling occurred.

Industrial Evaluation

These tests to determine the important characteristics of surface hardness, resistance to abrasion, ductility and adherence are important, but the real value of the new process depends upon their evaluation as determined by use in various industrial applications.

The qualities of being lightweight and of having abrasion resistance, which the chromium coated alu-

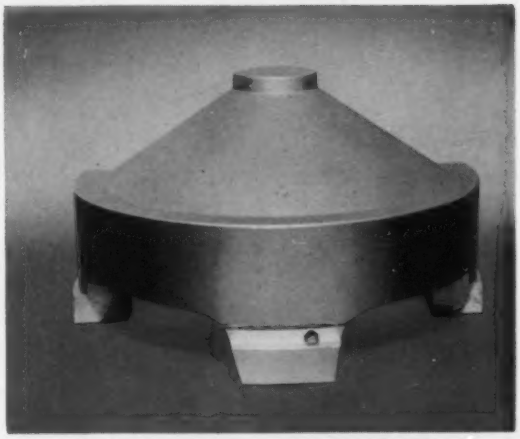


Fig. 4—No oxide contamination was transferred from this mold to the finished product, and the mold surface and release were improved after coating this mold for reinforced plastics with a chromium surface layer.

minum possesses, have led to some industrial applications for hard chromium plated aluminum parts in direct competition with certain types of steel. A large manufacturer of tabulating machines had been using imprint rolls made by engraving a non-magnetic stainless steel. The steel rolls had to be replaced after 8,000,000 impressions because of the loss of clarity. Now rolls are produced from an engraved 2024 aluminum roll that has been given a chromium deposit by the new process, and they are still in service after having made over 18,000,000 impressions (See Fig. 3)

Fig. 4 illustrates a successful industrial application of chromium coated aluminum used in the making of molds for reinforced plastics. Chromium coating the surface of the mold produced a better mold surface that prevented the transfer of oxide contamination from the mold to the finished product, and at the same time eliminated the need for a parting agent to obtain

(*Continued on page 33*)

CARBURIZING OF TRUCK TRANSMISSION PARTS SPEEDED WITH NEW "MASS MARQUENCHING" SETUP

By **E. A. Schoefer,** *Executive Vice President*
Alloy Casting Institute

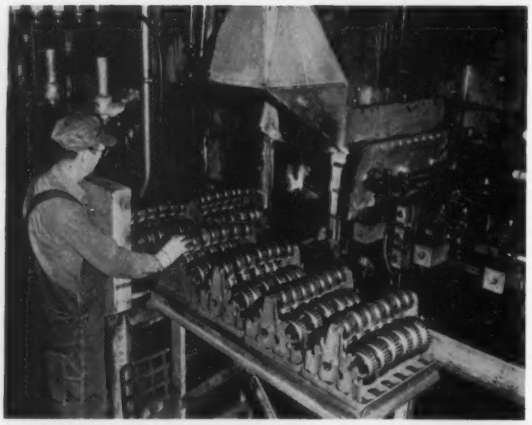


Fig. 1—Truck transmission parts on high alloy trays are loaded into gas carburizing furnaces at Fort Wayne Works of the International Harvester Company.

A MILLION-DOLLAR program for the modernization of heat treating facilities at the Fort Wayne Works of the International Harvester Company has been completed with generous use of cast high alloy components. Replacing relatively inefficient methods, a new "mass marquenching" technique, developed by W. B. Cheney, Asst. Works Metallurgist, and W. C. Hiatt, Asst. General Foreman, Heat Treat, of the Fort Wayne Works, is the heart of the new installation. Five gas furnaces, processing parts on specially-designed high alloy trays (Fig. 1), are speeding the carburizing of truck gears, king pins and shafts.

The "simple" gas carburizing setup used in former years was found both expensive and inefficient. Almost every part processed had to be straightened after heat treating. Parts had to be quenched individually and "fished out" of the quenching medium. For all this, a great deal of expensive hand labor was involved. This procedure was costly, and the properties of the products obtained were unsatisfactory. The conventional quench into oil or water at 90 to 100 F. created high internal stresses. These stresses caused distortion of the parts, necessitating subsequent straightening operations.

Marquenching is an ideal treatment for such heavily loaded parts as truck gears. Marquenching permits transformation of austenite to martensite by means of an interrupted quench, with oil at 400 F used as the quenching medium. This is carried out by placing the piece in the quenching bath at a temperature just above the M_s point (Fig. 2) of the carburized case, holding in the bath long enough to permit the piece to acquire the same temperature throughout, and then air cooling to room temperature. Transformation to martensite occurs during the relatively slow air cooling and, since the temperature gradient characteristic of conventional quenching is absent, the stresses set up by the transformation are much lower. Along with these lower stresses, there is much greater freedom from distortion and cracking.

Modernization of Furnace Line

In the program of modernizing heat treating facilities at the International Harvester Fort Wayne Works, special attention was given to the battery of five radiant-tube gas carburizers, supplied by Surface Combustion Corporation, used in connection with marquenching of the truck gears. These continuous carburizing furnaces have two rows each, accommodating 21 trays per row, on which the work is automatically charged into the furnace. The atmosphere in these furnaces consists of RX gas as a carrier, and 1050 Btu natural gas as an activator, in a ratio of 1250 cubic feet RX to 35 cubic feet of natural gas, with a

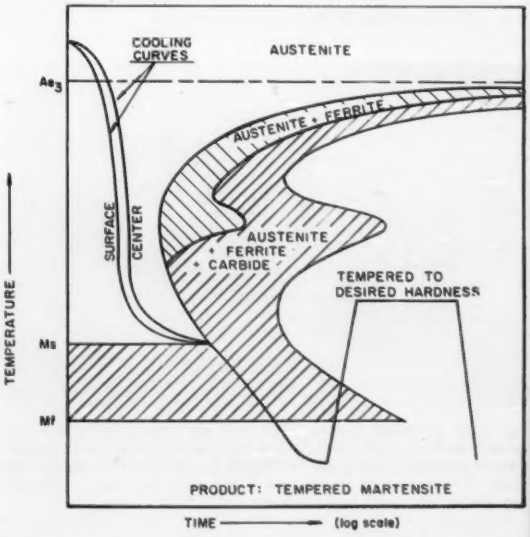


Fig. 2—Schematic diagram illustrating marquenching transformation of austenite to martensite.

(Continued on page 48)

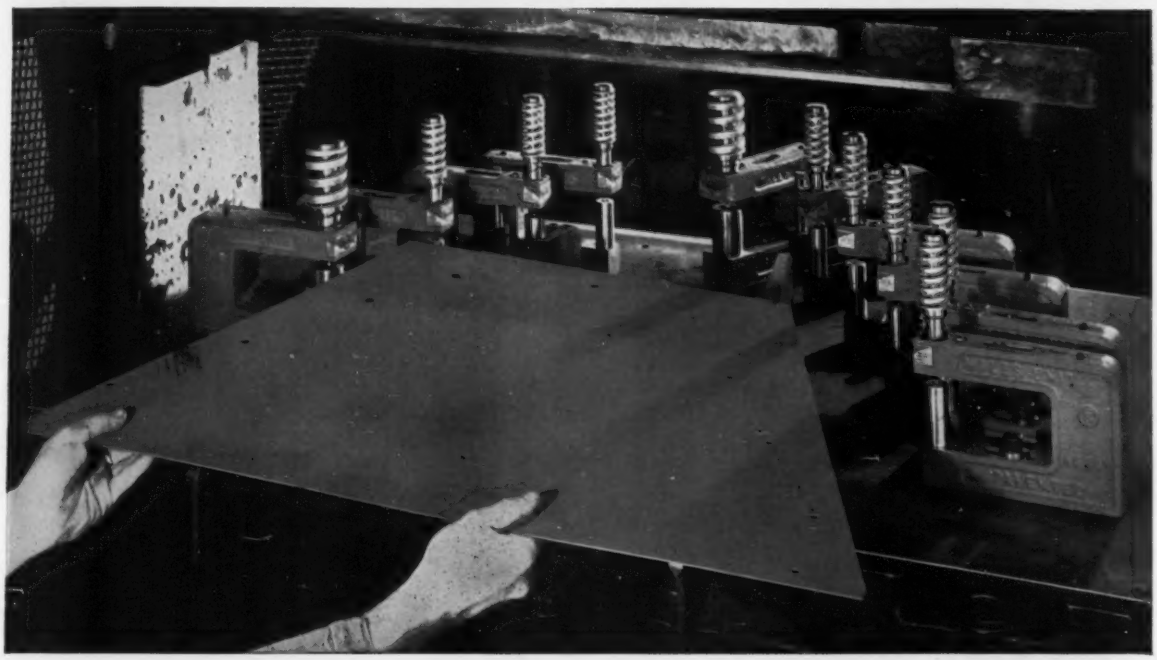
Tool Steel Topics

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Omega Punches, Used in Multiple Units, Provide Big Savings in Metal Punching

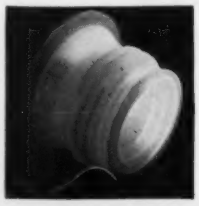
If you'd like to see some interesting metal-punching jobs, the place to visit is Wales-Strippit Company, at North Tonawanda, N. Y. There they employ about every punching operation imaginable, using self-contained punching units which are set up quickly to meet the requirements for varied hole sizes or shapes.

One of the tool steel grades which has been doing a fine job of minimizing shop costs at Wales-Strippit Company is Bethlehem Omega, a super-tough steel supplied by Leed Steel Co., Buffalo. Omega's dependability and long service life have been remarkable . . . all the more so because it is used exclusively in punching hard metals, where high shock-resistance heads the list of requirements.

Omega is our "super" grade of oil-hardening, shock-resisting tool steel. It can also be quenched in water. Here's its typical analysis:

C	Mn	Si	Mo	Va
0.60	0.70	1.85	0.45	0.25

Omega isn't limited to service in punches, either. It's just what the doctor ordered for hand and pneumatic chipping chisels, knockout pins, swaging dies, shear blades, and other uses where the steel is continually subjected to severe shock.



Making Plastic Parts? Use Lustre-Die

Lustre-Die, our new plastic-molding tool steel, is really something! What a high polish it takes! And what high lustre you get on the finished parts! Lustre-Die has a well-balanced analysis, and is alloy fortified to increase its depth of hardenability and mechanical properties. It's good steel. You'll like it.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Oxide Skin Improves Lehigh H

Most users of hot-work steels know that the oxide skin, put on the surface of tools by the second temper, is beneficial. This oxide coating serves partly as a lubricant, and also helps conventional lubricants to adhere, thus increasing wear-resistance.

When tempers above 900 F are used, Lehigh H tool steel is also benefited in the same way by the oxide coating resulting from the second temper. Here is the sequence of operations to be followed in heat-treating Lehigh H, so as to take advantage of the oxide coating:

1. Heat the tool and quench it in the conventional manner.
2. Temper at 925 F (or higher for some purposes).
3. Grind the tool to size, and remove scale and decarburization.
4. Retemper the tool at 900 F. Do not grind or remove the light oxide coating—use the tool with this surface.

Right Or Wrong In

LABOR RELATIONS

Editor's Note: *This department presents, in each issue, a round-up of day-to-day in-plant problems and how they were handled by management. Each incident is taken from a true-life grievance which went to arbitration. Sources of these cases will be given upon request.*

Can You Fire An Employee For Being Absent If He Notifies You In Advance?

What Happened:

There was no love lost between Manford Short, a worker, and his foreman, Tom Atwells. One morning, Short came over to his boss and said that he had to take a day off the following week. "Why?" Atwells asked. Short didn't answer. He just scowled and walked out.

The day before he was to be absent, Short reminded his supervisor, "Better get a replacement for me tomorrow. I'm not coming in," he said. "You better come in," the foreman shot back. "If you won't give me a reason for your absence, I won't give you permission."

The next day Short didn't show up. When he did return the day after, he was fired. He filed a grievance.

1. I gave my foreman plenty of advance notice—a week, in fact.
2. I don't have to give a reason for staying away from my job. After all, I'm not getting paid for the day I took off. The foreman is too nosey anyway.

The company, defending the foreman's position put it this way:

- A worker has no right to take off without permission unless he is sick.
- He must give a reason for wanting a day off and that reason must be acceptable to management.
- If everybody took off when they wanted to, how would we run a business?

Was the Company: RIGHT ☐ WRONG ☐

What Arbitrator R. N. Latture Ruled:

"On the basis of the evidence presented at the hearing, it seems to the arbitrator that the Company was not fully justified in discharging Manford Short. Mr. Short has some faults. He was unjustifiably stubborn in his refusal to go to the office to explain his absence when requested to do so by his foreman. However, his action in giving notice well in advance when he wished to be off a day shows a commendable regard for good practice. It is the decision of the arbitrator that Manford Short is entitled to reinstatement in his job without loss of seniority or other rights, and without compensation for time lost".

Can You Discharge An Employee If He Exercises His Right Of Free Speech On Company Property, But During Non-Working Hours?

What Happened:

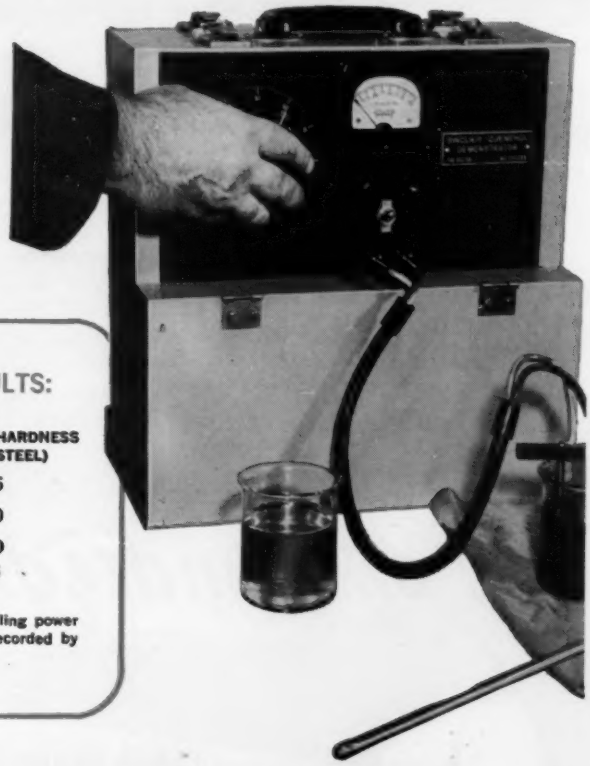
James Hammond's avocation was missionary work. When he took a job in a manufacturing plant, he asked his foreman for permission to make some missionary talks during lunch time and before starting

(Continued on page 24)

TEST PROVES QUENCHOL'S HIGHER COOLING POWER!

10-MINUTE DEMONSTRATION

Compare any oil you now use with Sinclair QUENCHOL 521 in just 10 minutes! Right in your office or plant, Sinclair's new Quenchol Demonstrator will give you an accurate comparison of relative cooling power . . . show you how QUENCHOL can save money in your quenching operations!



A TYPICAL TEST SHOWS THESE RESULTS:

OILS COMPARED	COOLING POWER*	ROCKWELL C HARDNESS (SAE 1045 STEEL)
Competitive Oil A	576	23.5
Competitive Oil B	729	39.0
Competitive Oil C	1024	41.0
QUENCHOL 521	1369	54.5

*Based on a recognized formula for determining relative cooling power value. Measured as the square of the current (I^2max.) as recorded by Quenchol Demonstrator.

ACTUAL PRODUCTION TOO...PROVES QUENCHOL SUPERIORITY!

In numerous production tests, QUENCHOL 521 has demonstrated its far superior quenching ability. All users report better results in the degree, depth, and uniformity of hardnesses obtained. Steels have included SAE 1035, 1040, 4140, etc. In many cases the superior results have been obtained while increasing working loads! Moreover, QUENCHOL's high sludge resistance, low acid formation characteristics and *high quenching reserve* keep it from deteriorating . . . extend QUENCHOL's amazing cooling power with longer service life!

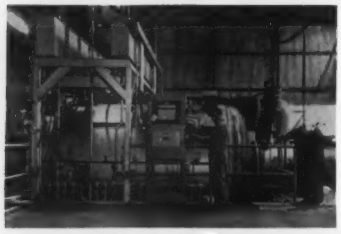
For your own demonstration of QUENCHOL efficiency, and for more technical information on its properties, call your local Sinclair Representative . . . or write to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR METAL WORKING OILS

NEWS TO HEAT TREATERS...

VACUUM ANNEALING FURNACE FOR TITANIUM PROCESSING

A vacuum annealing furnace of new design, said to be the largest in capacity of its type ever built, has gone into service at Mallory-Sharon Titanium Corporation, Niles, Ohio, where it will serve a dual purpose of quality improvement and heat treatment of titanium sheets.

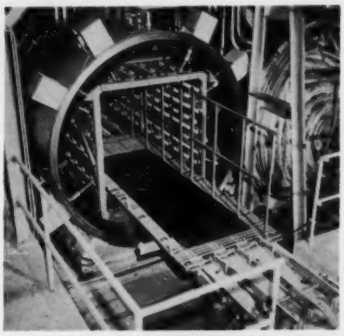


Vacuum annealing furnace at Mallory-Sharon Titanium Corporation.

The furnace, built by Westinghouse Electric Corporation, was designed by Westinghouse and Mallory-Sharon engineers working together with the specific requirements of titanium in mind. In the Mallory-Sharon unit, sheets can be either loaded flat on a charging car, which is rolled into the furnace, or suspended vertically in the conventional manner.

The flat loading method eliminates waste resulting from punching of sheets for vertical hanging, and also streamlines handling. The furnace, which has a charge space of 4 x 4 x 12 feet, can process several tons of material per charge. The unit has a rating of 450 KW, a maximum operating temperature of 1600°F, and can be evacuated to one millionth of an atmosphere.

The horizontal charging method was made possible by the elimination of insulating materials, a second major innovation in furnace design. No refractory brick linings are used. Since most of the heat transfer in a furnace is by radiation, rather than convection, the heating elements are placed within the retort, and radiation shields serve as thermal insulation. The exterior of the furnace is water cooled to prevent distortion by warping.



The furnace is shown here with end cover swung out of position to permit entry of charging car. Only a few titanium sheets are shown on the platform, however, the furnace can handle several tons of material per charge. Horizontal charging method greatly speeds handling of material to be annealed.

According to Mallory-Sharon engineers, vacuum annealing will be used where required to reduce hydrogen content of finished titanium sheet material. Present specifications generally call for no more than 150 parts per million of hydrogen in titanium sheet. In addition, vacuum annealing also constitutes a heat treatment.

For further information circle No. 1

HIGH FREQUENCY MOTOR GENERATORS

A new line of high frequency, vertical motor generators for induction heat treating applications such as melting, forging, brazing, annealing and hardening has been introduced by Welduction Corporation, Oak Park, Michigan. Generator ratings from 10 KW to 250 KW outputs are available in frequencies of 1,000, 3,000 and 10,000 cycles per second. Higher kilowatt rated generators and other frequencies are available on request.

Motor generators are totally en-

(Continued on page 18)

HEAT TREATING HINTS

Did You Know —

THAT The optimum salt concentration in a brine quenching solution is approximately 10%. This can be determined, for all practical purposes, by adding salt until a potato floats in the brine solution.

THAT When large amounts of steel must be removed in making a tool or die, a stress relieving treatment between the roughing and finishing cuts is desirable to minimize the possibility of distortion in subsequent hardening.

THAT Air hardening steels should be cooled (or quenched) supported in such a manner as to allow free circulation of air on all surfaces.

THAT Oil quenching tanks should be checked and cleaned at regular intervals to prevent build-up of sludge and water.

THAT In all cases, recommended heat treating temperatures are steel temperatures and are not necessarily furnace temperatures.

THAT When rehardening is required, the tool or die should be fully annealed before the rehardening treatment.

THAT To reduce the possibilities of distortion during the subsequent heat treatment of square or rectangular sections, equal amounts of stock should be removed from opposite surfaces prior to layout.

THAT Tools and dies should be placed in a furnace in such a manner as to provide adequate support and uniform heating.

THAT Double tempering is one important factor in insuring maximum tool or die life.

THAT Oil quenching tanks should be operated at about 120°-140° F. for most efficient quenching; water and brine quenching tanks at about 90° F.

THAT Sharp inside corners should have fillets, if at all possible. Remember sharp corners, sharp tool marks, deep stamp marks, and sharp nicks can cause cracking in heat treating, or premature failure in subsequent operation.

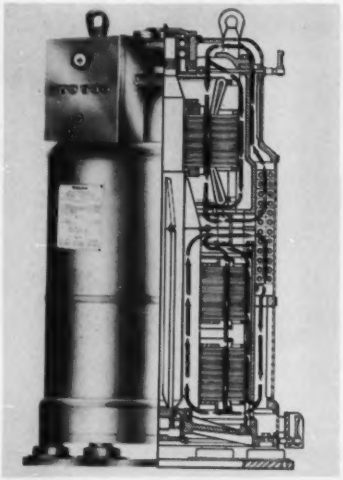
Source—Crucible Steel Company of America

Editor's Note: *If you have any items of interest, please send them along.*

NEWS TO HEAT TREATERS

(*Continued from page* 14)

closed and are cooled by fin type copper tube heat exchangers. Centrally located impeller fan distributes forced air cooling equally over motor and generator components.



The motor and generator rotors are mounted on a common vertical shaft. The shaft is suspended from two (2) radial thrust bearings on the top and rides on roller type radial bearings at the bottom.

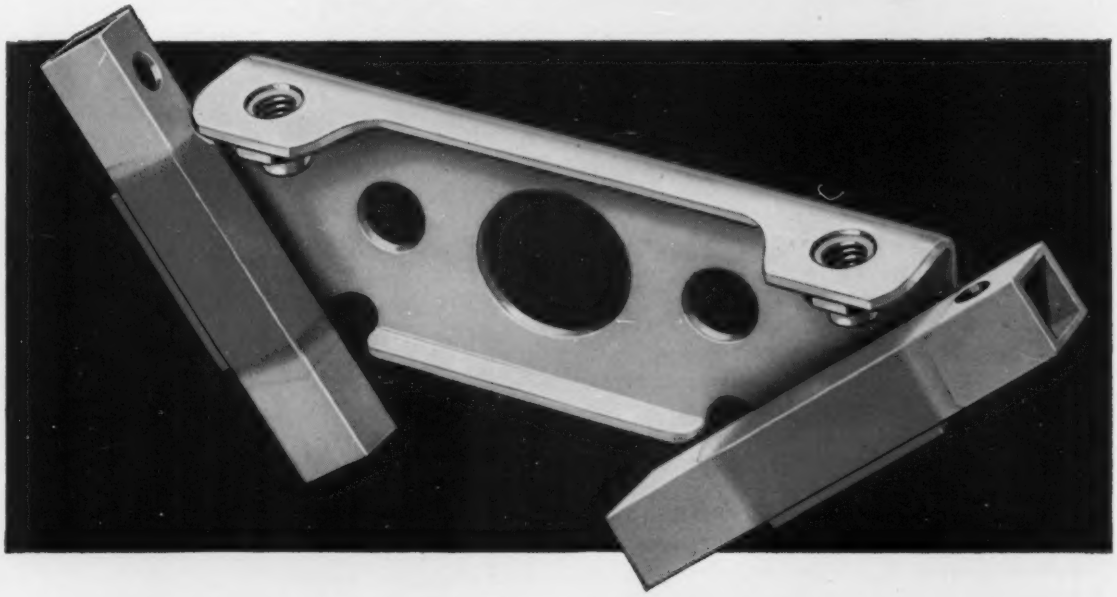
Complete protection of bearings and air temperature is provided by a thermostatic cutoff. This generator also has cut-off protection for water pressure and temperature.

For further information circle No. 2

(*Continued on page* 30)

Jack & Heintz Saves $15.84 Per Hour...

with TOCCO Induction Brazing*



Brazing Costs Down—When Jack & Heintz engineers switched from torch brazing to automatic induction, brazing cost of these inverter brush mounts fell from $.05 to $.006 each—a reduction of 83% in direct labor costs alone! Additional savings result because less cleaning is required after TOCCO, and fuel costs are much lower, too.

Brazing Production Up—While costs dropped, production on the part zoomed—from 40 to 360 brazed assemblies per hour. Furthermore, rejects and scrap, formerly high, are now negligible.

Versatility—The part shown is just one of over 25 parts, large and small, which alert J & H engineers have converted from old-fashioned brazing methods to modern, automatic TOCCO. Overall brazing costs (TOCCO brazing versus former methods used) are down 75%—brazing speed, up 100%.

If the manufacture of your product involves brazing, heat-treating, forging or melting of ferrous or non-ferrous metals, don't overlook TOCCO as a sound method of increasing production, improving product quality and slashing costs.

THE OHIO CRANKSHAFT COMPANY

Mail Coupon Today — **NEW FREE Bulletin**

The Ohio Crankshaft Co. • Dept. GG-1, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering".

Name_____

Position_____

Company_____

Address_____

City_____ Zone____ State_____

THE APPRENTICE CORNER

Editor's Note: *The following column appears regularly in METAL TREATING and is designed to aid young men who have only recently started in the heat treating industry. If you would like to see specific subjects discussed, or if you have any questions, let us know what they are.*

STRAIGHTENING

Straightening, by methods other than during the martensite transformation period, (see Sept.-Oct. issue, p. 36), or jig temper straightening, (see Nov.-Dec. issue, p. 22), is generally considered a mechanical operation. Press straightening, peening, hammering, torch spotting or shot peening are the methods used to meet the tolerance requirements.

It is not always possible, practical, or economical to straighten parts during the heat treat procedure. Mechanical methods are very often the only solution. The best method for any specific process depends on several factors; namely, hardness, size and shape, steel or alloy classification, heat treating process, and finish grinding after heat treatment.

Bar stock heat treated for tensile strengths of 150,000 psi is always press or roll straightened after hardening and tempering. A subsequent reheating after straightening is required to relieve the stress set up by the mechanical deformation during the straightening. This temperature is approximately 100°F. lower than the original tempering temperature. Commercial heat treating companies often specialize in this type of work.

Hammer peening is generally employed on steels requiring high hardness. In most cases the items are usually small in cross-section as compared to length. Reamers, broaches, shafts are examples of items that may be straightened in this fashion. Peening, however, has limitations insofar as the subsequent grinding of a peened area releases some of the surface stresses. If, in the final finishing operation, only a small amount of stock is removed, the stresses remaining will usually be sufficient to keep the part within tolerance.

The item to be straightened is always struck on the low or concave side. Several light instead of fewer heavier blows are preferred. The hammers used are "V" shaped on the striking edge and hardened to prevent mushrooming.

Shot peening or sand blasting is generally only applicable to smaller cross-sectional parts. The stresses set up in the work by shot peening are concentrated only in the outer surface, and consequently any surface grinding will remove these stresses and cause the part to assume its original distortion.

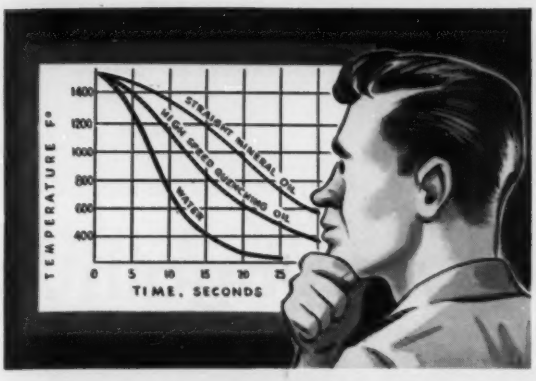
Torch spotting in almost every case a last resort, may be successful where other techniques fail. The item requiring straightening is subjected to the intense heat of an acetylene torch until the area directly beneath the flame becomes hot; approximately 900-1100°F. The heated spot is cooled with a wet sponge or rag to prevent hardness loss in the surrounding areas. The part requiring straightening is heated and cooled on the high or convex side. Both the heating and cooling must be applied rapidly for best results. Oil or water hardening tool steels of high hardness levels or alloy steels of medium hardness levels may be straightened in this manner.

There are, however, very definite limitations that must be observed. Excessive torch spotting may cause the tool to be unable to meet full service requirments. Spotting of working surfacs and edges must be avoided. Steels of high hardness levels may flake in the torch-spotted area and render the tool worthless. Never apply this technique to items requiring maximum tool life or to parts subjected to high stresses such as aircraft fittings or forgings. Carburized and hardened or case hardened parts can also be torch spotted. In most instances parts hardened by these procedures will permit torch spotting of the non-working surfaces without affecting the ultimate tool life. Grinding of torch straightened parts or areas does not effect the final straightness tolerances as much as the grinding of shot blasted or peened surfaces. It is, however, important that the grinding is done with extreme care to prevent cracking of the spotted portion.

Hammer straightening is the process of striking the high or bowed surface of the part placed on two or more supports. If this technique is used while the work piece is still cooling from the quenching process it is an adaptation of the martensite transformation period type of straightening and is a very successful method when applicable, especially in the case of tool steels of high hardness levels.

There are, however, some classes of work where peculiarity of the part or mass production quenching prevents hammering each item during its cooling period. Case hardened articles are generally of this nature. However, such parts may be hammer straightened cold if requirements call for very close tolerances. Excessively distorted case hardened parts may be straightened satisfactorily but in such condition that the surface exhibits fine cracks, a condition that may be acceptable, certainly, but is not commendable.

Fred Heinzelman, Jr., Fred Heinzelman & Sons



1. Quenching Speed. There are two basic types of quenching oils...straight mineral oils and compounded high-speed oils. If you can get the microstructure and hardness you need and have no distortion problems with a straight mineral oil, then it's the type to use. If you're not getting the results you want, increased agitation may help. If increased agitation doesn't help, or isn't practical, you should use a high-speed oil.

2. Naphthenic vs. Paraffinic. Both types of oil are used for quenching. Both have their own inherent advantages. Naphthenic oils keep oil coolers cleaner when the temperature of the oil doesn't exceed 150 F. A fully dewaxed paraffinic oil gives the most satisfactory results at temperatures over 150 F. As a rule, when all other operating factors are equal, the temperature of your oil bath tells you which type of oil to use.

What's the difference in quenching oils?

3. Thermal Stability. This is the biggest single factor influencing the useful life of a quenching oil. The higher the temperature of the oil bath, the shorter the life of any given oil. As mentioned before, at temperatures over 150 F it takes a stable, fully dewaxed paraffinic oil to give the most satisfactory results. For maximum useful life at temperatures over 200 F you will probably need a specially inhibited quenching oil.

4. Other Considerations. When quenching from a salt pot, use a straight mineral oil. Don't use an oil containing lard oil or other vegetable or animal fats. The salt carried into the oil on the parts will cause these fats to saponify and form oil-thickening grease. For bright quenching, experience shows that a straight mineral oil will give the best over-all results. For the most part, a straight oil will give cleaner parts longer.

These facts are nothing more than a guide to help you select the quenching oil best suited to your particular needs. To arrive at the final answer, there's no substitute for experience. Sun's representatives, backed up by Sun's metallurgical staff, have that experience. And, they're backed up by a *complete* line of quenching oils, paraffinic or naphthenic, regular or high-speed, straight or inhibited. Sun makes them all. For more information, see your Sun representative or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MR-1.

INDUSTRIAL PRODUCTS DEPARTMENT

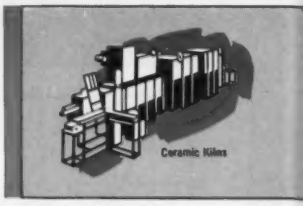
SUN OIL COMPANY

PHILADELPHIA 3, PA. SUN OIL CO.

IN CANADA: SUN OIL COMPANY, LIMITED, TORONTO and MONTREAL

SUNOCO

BRAND-NEW IDEA in heat treating furnaces



proving again . . .

FOR CARBONITRIDING, BRIGHT HARDENING, CARBURIZING OF SMALL METAL PARTS

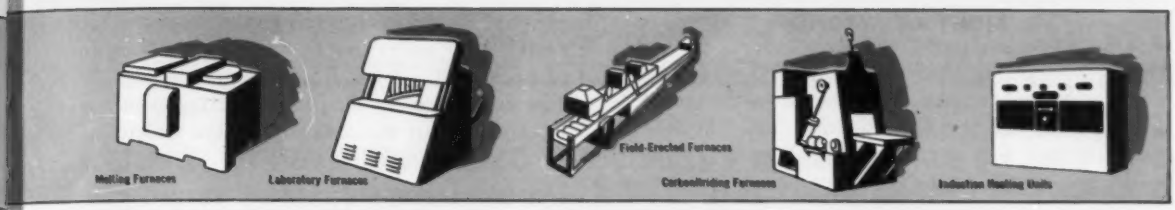
This is a completely new furnace, an exclusive Lindberg development. It is the first time induction heating has ever been offered in a heat treating furnace. No elements, no burners, no electrical or gas connections in it. Heating efficiency is high and the furnace can be brought to hardening temperatures in 17 minutes from cold. Temperature control is highly accurate, eliminating temperature override and lag for all practical purposes.

The Induct-O-Ring's circular shape eliminates door-opening heat and atmosphere losses and saves floor space. Work load is automatically charged and moved through the work chamber by a gentle, quiet, reciprocating movement of the furnace. The furnace is completely adaptable to automatic production processes, where its precise heat control, negligible maintenance and dependable operation are of particular importance.

- **No elements, no burners**
- **No gas or electric connections in furnace**
- **Built like a fine machine tool**
- **Precise temperature control**
- **Very low maintenance**
- **Quiet, automatic, trouble-free**

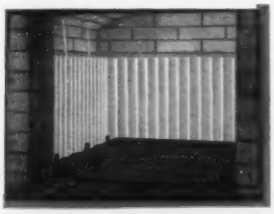
induct-O-ring*

*U.S. and foreign patents pending

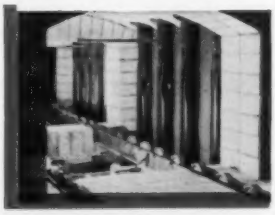


. . . it's better to talk it over with LINDBERG

If you are concerned with the application of heat to industry it makes good sense to talk it over with the most widely experienced experts you can find. We believe we have them here at Lindberg. Our only job is developing industrial heating equipment and we offer the most complete line in the field; heat treating furnaces, melting furnaces, high-frequency induction units, ceramic kilns; big ones, small ones, built in our own plant or field-erected. This gives us the experience and know-how to come up with something really new, like this revolutionary Induct-O-Ring furnace, time and time again. So take your industrial heating problems to the experts. Our engineers and technicians can have the right answer. Talk it over with Lindberg.



Another Lindberg achievement! The use of electricity in carbonitriding and carburizing furnaces has been made completely practical by Lindberg's recent development of the CORRTHERM electric heating element. This element is now being used in many furnace installations where ordinary electric heating elements could not operate successfully.



For fuel-fired furnaces, another important development, the famous "dimple" vertical radiant tube was created by Lindberg. This lightweight, easily-changed tube provides a big advance in furnace efficiency and effects a marked saving in operation and maintenance costs. Minimizes shut-downs and costs for tube changes.

Through the years Lindberg research and development laboratories have originated and perfected many other important heating processes, developments such as the Cyclone tempering furnace, automatic control of carbon potential in furnace atmospheres, 60 cycle induction melting and completely automatic ceramic kilns.

Many important Lindberg developments have come as a direct result of some good customer's need. With the customer's cooperation Lindberg engineers have frequently provided an answer to some pressing production problem. You will benefit, too, whether you need some specific Lindberg equipment or have an industrial heating problem that needs a solution if you'll just talk it over with Lindberg. Call your nearest Lindberg Field Representative. There's one (see your phone book) in every major industrial center.

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street, Chicago 12, Illinois
Los Angeles Plant: 11937 S. Regentview Ave., at Downey, Calif.

Associate Companies: Lindberg Industrial Corporation, Chicago • EFCO-Lindberg, Ltd., Montreal, Canada • Lindberg Italiana, Milan, Italy • The Electric Furnace Company, Ltd., Weybridge, Surrey, England • Etablissements Jean Aubé, Paris, France • Lindberg Industrie Ofenbau, Gross Auheim, Germany • Toyo Menka, Tokyo • Lindberg Engineering Company (Australia) Pty. Ltd., Melbourne

RIGHT OR WRONG

(*Continued from page* 12)

time. His "sermons" were to be inspirational in tone and not denominational. His audience would consist only of those who wanted to listen to him. The foreman told him he could give his talks as long as he didn't go "on the production line."

Hammond stuck to this agreement and spoke only during lunch hour and before the start of the shift. For a while there was no objection from his fellow-employees, but then some objected, saying that the plant was no place for these sermons. Management took note of these objections and asked Hammond to stop using company property for this purpose. Hammond paid no attention to this request but continued his talks. After several verbal warnings, the company fired him.

The union took up the cudgels in Hammond's behalf, claiming that the company's action violated the basic right to freedom of speech and worship.

Was the Company: RIGHT ☐ WRONG ☐

What A Three-Man Arbitration Board Ruled:

"It is the opinion of the chairman that freedom of speech is not an issue in this case. The issue, as the chairman sees it, is whether or not the Company must permit its propery to be used for purposes other than those for which it was established and is conducted. Certainly the Company cannot prohibit a normal interchange of ideas and expressions of opinion by employees, common in all plants, and a natural incident to places where men gather for work or other purposes. But it is an *abnormal* and essentially different purpose to which Rev. Hammond sought to use the premises. The fact that he did preach for some time without objection and without an order from management to desist does not, in the chairman's opinion, destroy the right of the Company to control the use of its property and the right to order the practice stopped after there was complaint." Grievance denied. ■■■

THERE'S A HEAT TREATING SPECIALIST NEAR YOUR PLANT

CALIFORNIA

ertified Steel Treating Co.
2454 E. 58th St., Los Angeles 58

ollywood Heat Treating Co.
6902 Santa Monica Blvd., Los Angeles 38

indberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23

ook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

ommercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6

tanley P. Rockwell Co.
296 Homestead Ave., Hartford 12

ILLINOIS

enecca Heat Treating Co.
124 S. Batavia Ave., Batavia

ccurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12

ura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22

earson Industrial Steel Treating Co.
5757 W. Ogden Ave., Chicago 50

erfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22

red A. Snow Co.
1942 West Kinzie St., Chicago 22

merican Steel Treating Co.
P. O. Box 225, Crystal Lake

klund Metal Treating, Inc.
721 Beacon St., Loves Park

ndberg Steel Treating Co.
1975 N. Ruby St., Melrose Park

. T. Muchlemeyer Heat Treating Co.
1531 Preston St., Rockford

. U. Scott & Son, Inc.
1510 First Ave., Rock Island

MASSACHUSETTS

ew England Metallurgical Corp.
475 Dorchester Ave., South Boston 27

orter Forge & Furnace, Inc.
74 Foley St., Somerville 43

reenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Anderson Steel Treating Co.
1337 Maple St., Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Michigan Steel Processing Co.
3120 Denton, Detroit 11
Standard Steel Treating Co.
3468 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Metallurgical Processing Company
2703 East Nine Mile Road, Hazel Park
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1727 Manchester Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Metal Treating Corp.
611 Grove St., Elizabeth
American Metal Treatment Co.
Highway 25 and LaFayette St., Elizabeth
Benedict-Miller, Inc.
Marin Ave. and Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E., Rochester 5
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 25
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 West Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Robert Wooler
Limekiln Pike, Dresher
J. W. Rex Co.
834 West 3rd St., Lansdale
Drever Company
220 West Cambria St., Philadelphia 33
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 East Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
4272 Wissahickon Ave., Philadelphia 32
Pittsburgh Commercial Heat Treating Co.
49th St. and A.V.R.R., Pittsburgh 1

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 1686, Fort Worth 1
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
830 S. Fifth St., P. O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

B. & W. Precision Heat Treating Co.
70 Borden Ave., S., Kitchener, Ontario

NSTITUTE **271 NORTH AVENUE, NEW ROCHELLE, NEW YORK**

(*Continued from page 6*)

hardness values.

With the quenching medium selected, the size and shape of the tank to handle all the work necessary should be considered. Too small a tank is false economy; the rule of thumb for tank size is one gallon of oil for every pound of steel quenched per hour.

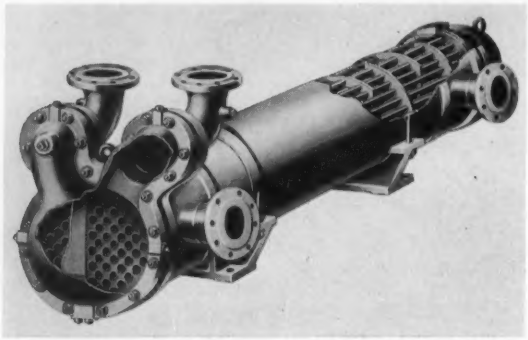


Fig. 8—Water-cooled tube type unit for quenching oil. *(Courtesy Schutte & Koerting Co.)*

Cooling the Oil

For continuous volume production where ratio of work to oil is high, the question of cooling becomes increasingly important. Standard methods now used include:

1. Submerged cooling coils containing circulating cold water.
2. Separate coils, pumping oil from tank and back again.
3. Heat exchanger units.

Location of the quench tank near the furnace, and ease of quenching (height of tank, etc.) are common-sense items to check.

Other sound hints or precautions are listed in a briefly written table accompanying this article.

Timing in the quench should be uniform for all like sections, otherwise a variation will exist in quenched structures, and carry through to the tempering operation.

Fig. 9—Niagara heat exchangers on roof of heat treat department. If located here the humid hot air can be discharged without necessity of venting.

Interrupted Quenching

No discussion of quenching would be complete without a reference to interrupted quenching, although that constitutes an entire subject in itself. Despite the slower speed of oil, quench cracks, distortion and lack of standard dimensional accuracy are still frequently a problem in the production of alloy steel items, particularly with thin and thick sections in the piece being treated.

To avoid these difficulties the interrupted quench—including martempering, austempering and modifications thereof—came into use during the past dozen years. While essentially a process for molten salt baths, it is also possible to handle high temperature quenching jobs in oil up to 400°F., there being oils available that will hold up for fairly long periods at elevated temperatures.

(*Continued on next page*)

COMMON-SENSE QUENCHING HINTS

1. *Oil Circulation*—Be sure all surfaces of parts to be quenched are exposed uniformly to the oil. Containers should be baffled. Avoid nesting of work.
2. Avoid use of *baskets* in quench where possible. It is better to dump small parts on a screen to be lifted out of bath. Basket congestion hinders even heating and cooling.
3. Avoid temperature variation when water is the quenching medium. Hold to 20° maximum spread.
4. When installing cooling coils, the water should run counter-flow to the oil so the hottest oil is exposed to the coldest water.
5. When drawing salt is used for martempering it should be watched for eventual chloride build-up which would create corrosive conditions should salts later be used for high-temperature tempering.
6. Before a drawing operation the quenching oil should be cleaned from the work to prevent the formation of carbonates in the drawing bath.
7. It is advisable to draw *immediately* after the quench, to relieve stresses and avoid quench cracks.
8. Work should be removed from the *quench* before it reaches the temperature of the oil. This also helps avoid distortion.
9. It may be well to equip oil quench tank with a tight *cover* readily put in place in event of oil being set on fire.
10. Always use *safety* shield and gloves to avoid injury or burn. Keep CO_2 extinguisher available in case of oil fire.

The comparative viscosity of a 100-second mineral quenching oil vs. a martempering oil is shown below:

VISCOSITY OF QUENCHING OILS

100-sec. Mineral at		Mar-Tep Oil No. 2 at	
84°F.	120 sec.	200°F.	148 sec.
100°F.	100 sec.	250°F.	87 sec.
120°F.	72 sec.	300°F.	54 sec.
140°F.	58 sec.	350°F.	44 sec.
		400°F.	39 sec.

This type of high temperature quenching oil can be fortified by wetting agent additions to increase quenching speed, and by anti-oxidants to promote stability at elevated temperatures.

Oil has a logical place in high temperature quenching, even though salt baths used for that purpose have gained more popularity. When work has been carburized in salt it must be carefully cleaned and washed before it can be transferred from the carburizing bath to one based on nitrates, as the two are not compatible, and a violent reaction would occur if they were mixed together. When oil is used for martempering this careful cleaning operation is not necessary. Carburized parts also clean much easier after the oil quench.

Martempering oil is not a replacement for the fast quenching oils needed for hardening lean alloy steels or others having a critical rate of hardenability. The faster oils are known to provide maximum hardness and greater depth of hardness. ■■■

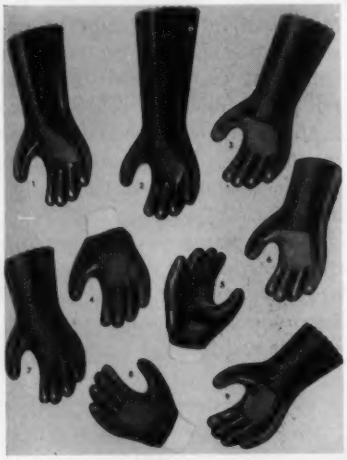
"SEE?-THIS QUENCHING OIL GIVES TOO GREAT A DIMENSIONAL CHANGE!"

NEWS TO HEAT TREATERS

(Continued from page 18)

INDUSTRIAL GLOVES

A new Pacemaker industrial glove line, by the Pioneer Rubber Company, Willard, Ohio, offers 15 design innovations—a specific glove for virtually every industrial use. The Pacemaker line, pictured below, includes: (1) 14½-inch industrial wt. gauntlet, (2) 18-inch industrial wt. gauntlet, (3) 14½-inch heavy duty gauntlet, (4) industrial wt. knit wrist, (5) heavy duty knit wrist, (6) 12-inch twin-lined heavy



duty "Hot 'N Cold" gauntlet, (7) 12-inch industrial wt. gauntlet, (8) light wt. (on 6-oz. twill) knit wrist, and (9) 12-inch heavy duty gauntlet.

For further information circle No. 3

PANGBORN LICENSES ENGLISH FIRM

Pangborn Corporation, Hagerstown, Md., manufacturers of Rotoblast airless blast cleaning and dry and wet dust control equipment, announce they have just signed an exclusive licensing agreement with Hepburn Conveyor Company, Limited, of Wakefield, England, for sole manufacturing and sales rights of Pangborn equipment in the following countries: England, Scotland, Wales, Ireland, Australia, New Zealand and Union of South Africa.

For further information circle No. 4

(Continued on page 36)

For solving a wide range of engineering problems—

This practical book gives engineers a firm grounding in the essential facts of metallurgy—for effectively determining which metal or processing method is best suited to the requirements of a particular job.

JUST OUT!

APPLIED METALLURGY FOR ENGINEERS

By MALCOLM S. BURTON

School of Chemical and Metallurgical Engineering, Cornell University

407 pages, 463 illustrations, $7.50

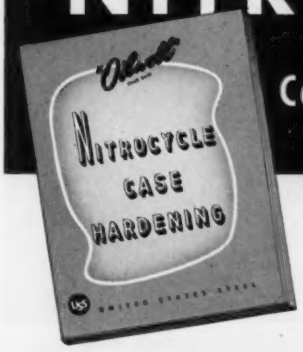
NO MATTER how limited your background in metallurgy may be, you can rely on this practical guide to help you select the *right* material or process for a given need. It gives you a firm grounding in methods of evaluating metals . . . explains their composition and properties . . . and demonstrates methods of examining and testing. Use of phase diagrams of various metallic alloy systems also is described. Welding, bonding, and related processes are covered as well as brazing, soldering, sintering, and gas and arc cutting. Modern equipment and latest techniques are described and illustrated.

Order now from:

METAL TREATING

271 NORTH AVE. NEW ROCHELLE, N. Y.

NITRIDE the Cost Cutting Way



This Handbook tells you HOW!

For extreme case hardness where distortion from heat presents a critical work factor, the revolutionary new process that is explained in this handbook will greatly reduce finishing costs.

Send for your free copy today!

OIL WELL SUPPLY DIVISION

UNITED STATES STEEL CORPORATION

Oil City, Pennsylvania

Licensor for the

USS NITROCYCLE PROCESS

UNITED STATES STEEL

NO.5 in a series of **ALUMICOAT APPLICATIONS**

For HIGH TEMPERATURE APPLICATIONS

Alumicoat

Molten Aluminum PROCESS

CAN PROTECT HEAT TREATING EQUIPMENT FROM CORROSION & HEAT OXIDATION!

The new, ALUMICOAT molten aluminum Process has been perfected to give steels added resistance to corrosion and heat oxidation where continuous high temperatures are a problem.

In the ALUMICOAT Process, heat treating fixtures, trays, etc. are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The ALUMICOAT Process can give you greater economies through the use of lighter yet more rugged fixtures with a longer life through added resistance to corrosion and heat oxidation!

Send for full details. Your inquiry is invited.

ARTHUR TICKLE ENGINEERING WORKS, INC.

19 Delevan Street MAin 5-4200 Brooklyn, N. Y.

Twice the life of previous heating elements!

...a report on "HOT RODS" in intermittent service

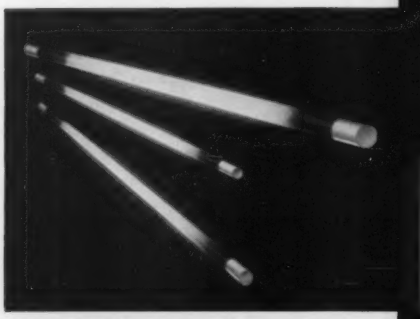
Many plants report Norton "Hot Rods" outlast other non-metallic elements by a considerable margin. Here's a case where they're lasting twice as long — in gruelling intermittent service.

This means big savings in element costs alone. You also save maintenance expense, due to less frequent changing of elements and voltage taps. And you don't have to shut down the furnace to replace elements.

Also, "Hot Rods" heat more uniformly, due to their slow, evenly matched rate of resistance increase. This helps protect product quality and maintain a smooth production flow.

The booklet, "*Norton Heating Elements,*" tells you more about how "Hot Rods" can help improve your furnace operations and cut costs. Write for your copy to NORTON COMPANY, Refractories Division, 620 New Bond Street, Worcester 6, Massachusetts.

After Hardening At 2200°F, white-hot hacksaw blades are lifted from a Lindberg hydrizing furnace in the plant of *G. W. Griffin Co.*, Franklin, N. H. — a well-known manufacturer of hacksaws. Norton CRYSTOLON* heating elements ("Hot Rods") are located in air outside the crucible which contains the protective atmosphere. Heating cycles are intermittent, the furnace being shut down each night. The "Hot Rods" in this installation have averaged twice the service life of the elements used previously.



CRYSTOLON Heating Elements, or "Hot Rods", are a typical Norton Rx — an expertly engineered refractory prescription for greater efficiency and economy in electric furnace and kiln operation. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes and interchangeable with your present rods.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products... to make your products better

(Continued from page 9)

mold release. Aluminum molds may be machined at greatly reduced cost in comparison with machining steel molds, and the chromium surface will increase the life of the aluminum molds to the extent of enabling them to compete with steel molds. Such aluminum molds have also been used by aircraft manufacturers, makers of fire helmets and by producers of gutters.

Furthermore, chromium coating of titanium parts has eliminated many of the objectionable characteristics of titanium which prevented its use for certain industrial applications. Because of the seizing and galling of titanium in any application that involves sliding contact, titanium cannot be used unless it is chrome plated. A manufacturer of armaments and experimental weapons specified that pistons made of titanium alloy 150A be coated by the new process and then tests were to be made.

After many rounds of firing, the pistons were removed and found to have resisted corrosion, scoring and abrasion better than untreated parts and were still in good condition for more use.

Another highly successful application of the process is in the coating of an aluminum pattern used in shell casting. The pattern was processed with a chromium surface of 0.003 inches thick. As shown in Fig. 5, the part has abrupt changes of section and irregular contours and yet the chromium surface is clear and sharp. This is due to the fact that the new process deposits a uniform thickness of chromium layer even in projecting areas. The old conventional plating baths had poor throwing power and often resulted in projections. The new process avoids this "treeing", gives a uniform surface thickness and thus provides good resistance to local stresses.

The Processes on Other Metals

The corporation has found and manufacturers have testified that depositing a tightly adherent, dense and ductile layer of chromium on other base metals such as steel, brass, beryllium copper, lead and zinc alloys is also highly satisfactory for various industrial applications. A technique known as the Sure Wear K process has been used on the teeth of a steel saw used for cutting metal. A chromium deposit layer 0.005 inches thick was made on the teeth, and tests have been reported that the life of the saw was increased 500 percent and that the sharpness of the teeth was not impaired.

Another process called Kromolloy was used to impart a hard surface to industrial steel files and rasps. They were used in a New England manufacturing plant, and a report was sent that the files were non-clogging, rust resistant, and lasted three times as long as untreated files.

An aircraft manufacturer reports excellent results and great economies by using a Kromolloy-processed band saw blade. Their experience with an unprocessed, 15-foot high-speed band saw blade used to cut Plexiglass was that after only one or two hours the blade became so hot that it literally burned its way through the glass-like fabric and in one day's operation two blades had to be used. Then after changing to a blade that had been processed by the Kromolloy method, the manufacturer reports that the cuts were not burned and a clear unfrayed edge resulted. Also that one blade lasted for five days before it had to be replaced.

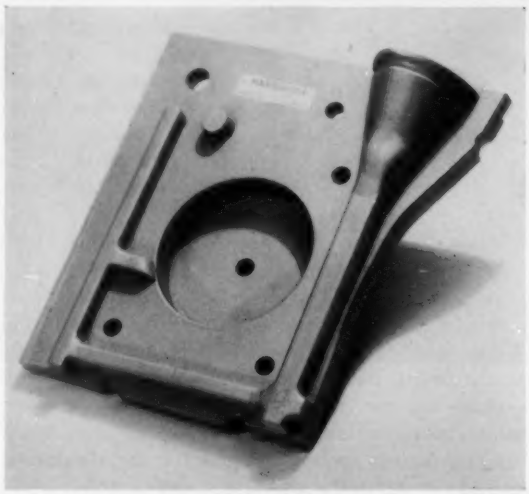


Fig. 5—This chromium surface is clear and sharp even with the abrupt section changes and irregular contours because of good throwing power.

Constant research is being conducted and new applications are being found for the new processes. Some of the most recent applications are for shell moldings, valve seats and stems, heating elements of cold-rolled steel, gears die cast of Zemas, and printing plates made of lead and zinc alloys.

In all of these uses, the cost of the new processes are favorable in comparison with the costs of the conventional chromium plating techniques. ■ ■ ■

Publication Committee Note: *Hard chromium plating to prevent frictional wear is not new. Each base metal presents its own unique problems. Those base metals which quickly form an oxide film under normal atmospheric conditions are particularly troublesome. The following article discusses some of the methods employed in solving the problems in connection with the particular metals discussed.*

M.T.I. *Activities*

1957 SPRING MEETING

Boca Raton Hotel, Boca Raton, Florida, has been selected as the headquarters for this year's Spring Meeting of the Metal Treating Institute which will be held on April 8, 9, and 10.

The facilities of this famous resort estate for both business and pleasure are so complete that this is truly a convention which no member can afford to miss.

From the technical and business side, a good program is being arranged. Mr. P. D. Frost of Battelle Memorial Institute will present an illustrated lecture on the latest developments in the heat treatmnt of titanium, and Mr. L. W. Kalinowski of Sinclair Refining Company will present an illustrated talk on hot oil quenching. Other business session activities will be announced later.

Nothing is being left undone in connection with the recreational side of the convention and in taking full advantage of the beautiful facilities of the resort and of Florida's sunshine. Plans are afoot for golf, tennis, deep sea fishing and swimming. There are six tennis courts, two golf courses, two swimming pools and the Atlantic Ocean to satisfy the desires for relaxation. A deep sea fishing contest, a special "steak broil" evening, and a special banquet for the concluding evening are all in the planning stage.

Reservations blanks have been sent to the membership and should be returned as soon as possible.

WISCONSIN MEETING

Of particular interest because of its unusual aspect was a meeting held at the Wisconsin Club, Milwaukee, Wisconsin, on the evening of December 5th. This meeting, sponsored by members Theodore Dolhun, Wisconsin Steel Treating and Blasting Co.; Clarence Graham, Metal Treating, Inc.; M. E. Huber, Supreme Metal Treating Co.; Robert Thurner, Thurner Heat Treating Co.; and Charles Wesley, Allied Metal Treating Corp., was a reception and dinner party given for about 30 steel salesmen.

Guest speaker was the Executive Secretary of the Metal Treating Institute, C. E. Herington, who spoke on "The MTI – What It Is and What It Does".

The national trade magazine METAL TREATING was discussed, and at the conclusion of the remarks, a lively question and answer period developed. The steelmen showed an active interest in how commercial heat treaters work with their mutual customers–the metalworkers. Of primary importance to the meeting was the development of a number of ways and means by which both can work together to the advantage of all three.

THE COMMERCIAL HEAT TREATING INDUSTRY—1956

The year 1956 closed with industrial activity gaining a momentum which started the year 1957 off at a very high level of production. From all indications the pace will be maintained or increased during the coming months.

The new models in the automotive field should create added impetus. The effect of Middle East tension should also nudge the defense and aircraft and guided missiles industries' production upward.

The Metal Treating Institute reports that the custom or commercial heat treating industry is expanding at a startling rate, both in number of dollars being invested in capital equipment and buildings and also in dollar volume of sales of services to the metalworking industry. The year 1956 was from 25 to 40 per cent above the year 1955, depending upon locality.

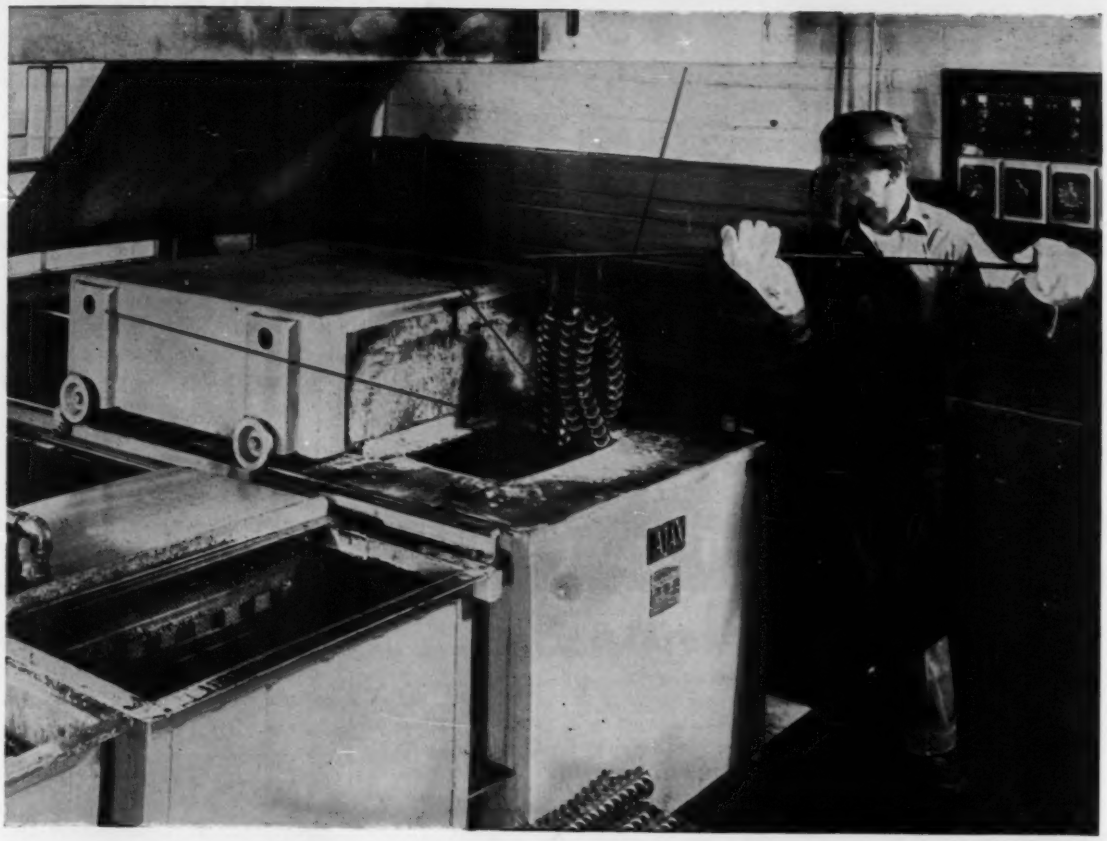
The wide experience gained by processing metals for a vast cross section of industrial America gives the commercial heat treater a distinct advantage in his ability to meet and solve the problems which are arising today and will continue to arise in the future.

These accumulative effects will spur and advance the development of techniques for vacuum annealing and heat treatment, especially in the field of titanium alloys. Larger and better designed equipment will be greatly expanded for heat treatment of titanium sheets and other fabricated components.

Huge furnaces of unique design have been and are being installed in commercial heat treating plants to handle the ever larger and more complex fabrications of stainless and heat resisting alloys being turned out in the atomic, jet, and guided missile fields. These new furnaces, though complex in design, are highly versatile in heating temperatures, varieties of atmospheres, and application of various cooling rates provided by different mediums of cooling.

Wider application of surface treatments such as induction and flame treating is being rapidly expanded.

Protection of finished parts by means of greater ease and control of gas atmospheres using infra-red rays as the controlling mechanism and greater use of controlled quenching for elimination of distortion are becoming common practice. *(Continued on page 36)*



SOMETHING NEW IN A WATER-SOLUBLE CARBURIZING SALT—*PERLITON 400*

The idea of a water-soluble carburizing salt that cleans off easily isn't new—but Perliton 400 is.

This Houghton salt hits a new high in carburizing value. Seldom is an energizer necessary.

It is extremely stable, lasts long months with less need for frequent time-wasting control tests and you get fast carbon penetration at the lower carburizing temperatures. The case structure is deep, hard and speedily obtained.

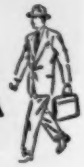
Write for a new Data Sheet on Perliton 400 direct to E. F. Houghton & Co. (pioneers in salt baths), 303 W. Lehigh Ave., Philadelphia 33, Penna.

HEAT TREATING SALTS

a product of . . .

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO



Ready to give you on-the-job service . . .

MTI ACTIVITIES

(*Continued from page 34*)

It is doubtful if industry as a whole realizes the tremendous potential that is contained within the custom or commercial heat treating field. A large, complete, and widely diversified service industry with thousands of highly skilled technicians and completely equipped plants are at the disposal of all manufacturers.

All in all, the custom heat treater is constantly progressing in his daily search for improvements in the application of heat to metals.

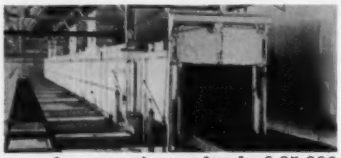
HOWARD N. BOSWORTH
President
Metal Treating Institute

NEWS TO HEAT TREATERS

(*Continued from page 30*)

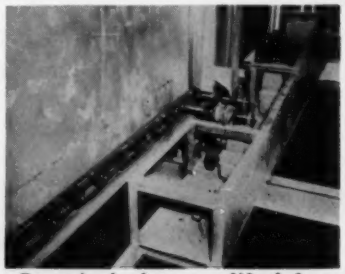
CONVEYORIZED TUNNEL OVEN

A new Conveyorized tunnel oven (upper photo) provides well-controlled heat treating of aluminum castings. The 140-foot-long oven



can take a maximum load of 65,000 pounds of aluminum parts and their containers, and production rate is about 150,000 pounds of castings in 24 hours.

The oven is pictured during completion recently by J. King Kent & Company, St. Louis, Mo., a manufacturer of industrial process equipment. It was designed and built for a prominent manufacturer of aluminum parts.



Parts in baskets are lifted from a lower floor by elevator, which discharges them onto a short sec-

(*Continued on page 38*)

LETTERS TO THE EDITOR

Dear Editor:

We have been using "METAL TREATING" for the past two years in advertising our high speed and tool steels and will, of course, plan on renewing our contract for 1957.

We have been very pleased with the wonderful response we have had from your readers and the interest they have shown in our products. We are also pleased with the response received from the articles which appeared in "METAL TREATING" from time to time.

Keep up the good work.

MICHAEL STUMM
Advertising Manager
Crucible Steel Company of America
Pittsburgh, Pennsylvania

Dear Editor:

I find your magazine extremely informative and of much use in keeping abreast of present heat treating trends.

Would you please change my mailing address.

E. C. BUCKINGHAM
Industrial Division
Pacific Scientific Company
Los Angeles, California

Dear Editor:

I am extremely glad to see the specimen copy of your magazine, METAL TREATING, March-April '56 issue. It contains valuable lot of information which I feel should not be missed by anybody in the Metal Treating Profession.

I will be much thankful if you can put me on the mailing list of your valuable journal, as I feel as the Foreman of Heat Treatment Shop, it will help me very much in solving many of my problems and improving the products.

S. RAMACHANDRAN, B.Sc., L.I.M.
Foreman, Heat Treatment Dept.
Indian Telephone Industries (Private) Ltd.,
Bangalore Dist. INDIA

NEWS TO HEAT TREATERS

(Continued from page 36)

tion of free-wheeling roller conveyor (at far end of oven) which operates at a speed greater than the oven conveyor speed. The load of aluminum parts is then driven at oven conveyor speed through roller-chain drive and overrunning clutch onto a roller-chain conveyor in the oven. Speed can be varied and controlled so that parts move through the oven in various selected periods of time, from 4 to 10 hours. Temperatures are as high as 450 degrees Fahrenheit.

For further information circle No. 5

WESTERN METAL CONGRESS AND EXPOSITION

Plans have been announced for the 10th Western Metal Congress and Exposition to be held in Los Angeles, California, March 25-29. The Exposition will have its exhibits in the Pan-Pacific Auditorium and in four specially-erected pavilions while the technical sessions of the Congress will be held in the Ambassador Hotel.

Eight technical sessions will be given by the American Society for Metals. Authoritative speakers will deliver papers on the selection, fabrication, machining and testing of metals. They wili speak on new developments for the aircraft, rocket, missile, electronics, petroleum, chemical and general industries. One entire session will refer to industrial heating.

Other societies to hold technical sessions will be the American Welding Society, Society for Nondestructive Testing, and American Institute of Mining, Metallurgical and Petroleum Engineers — Metals Branch.

Tuesday, March 26th, beginning at 9 a.m. will feature a session cosponsored by the Industrial Heating Equipment Association and ASM. Papers and authors are as follows:

"Salt Bath Brazing," by L. B. Rosseau, Vice President, Ajax Electric Company, Phila.

(Continued on page 40)

HEAT TREATING HELP

THE CARPENTER STEEL COMPANY, 198 W. Bern St., Reading, Pa. No. 3 in a series

HARDENING FURNACE ATMOSPHERE

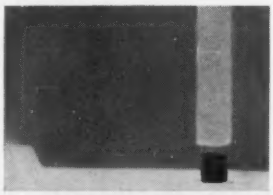
You can often **double** the life of a tool or die merely by hardening it from the proper furnace atmosphere.

With the use of liquid baths (molten metal or salt), obviously the problem of controlling the atmosphere in the combustion chamber is eliminated. If you use controlled atmosphere furnaces, we suggest that you follow closely the recommendations of the furnace manufacturer. With other types of furnaces please read the following instructions carefully.

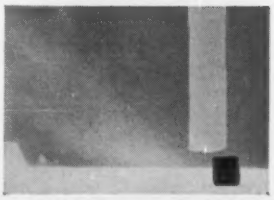
All Carpenter Matched Tool and Die Steels can be hardened free from decarburization. This is accomplished by following the instructions for the various types of furnace atmospheres given for each steel in published literature. The furnace atmosphere can be "analyzed by eye" by the following method.

To estimate **oxidizing atmosphere** between 1% oxygen and 5% oxygen, heat the furnace to the proper temperature and put a small block of wood (not over ¼" cube) on the hearth and close the door.

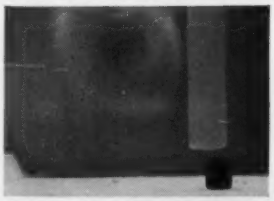
Observe the way the wood burns through the peep hole in the door.



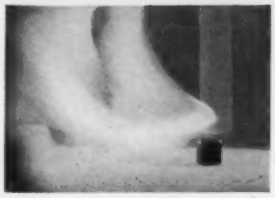
If the wood smokes, and chars, but shows no visible flame, the atmosphere contains less than 1½% oxygen. It may even be reducing.



If the wood block smokes, then shows intermittent flashes of pale blue flame (with no yellow in the flame), the oxygen is between 1½% and 2½%.

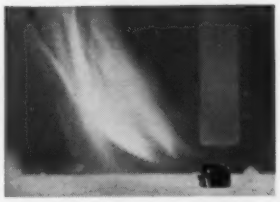


If the flame from the block is about half blue and half yellow, the oxygen is between 2½% and 4%.



If the wood block burns with a steady yellow flame —and if the residual charcoal glows pretty much all over—the oxygen is about 5% or above.

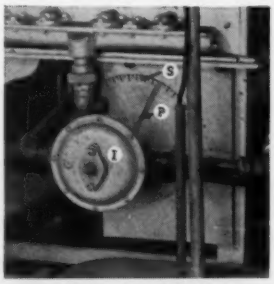
To judge excess oxygen of about 8% to 10%, put a small lump of soft coal on the hearth and observe it through the peep hole. Under 4% oxygen the coal will smoke, but will show no flame. Between 4% and 8% there will be flame and smoke mixed.



At 8% to 10% oxygen, there will be a trace of smoke—the coal will burn with a clear luminous flame —and the remaining coke will definitely glow.

The above tests can be used to estimate oxidizing atmospheres in a gas-fired furnace, or an oil-fired furnace, or a gas curtain electric furnace.

The beneficial effects of furnace atmosphere will be felt **only** on those tool surfaces which are exposed to a continuous **circulation** of furnace gases. The side of the tool that rests on the hearth, or holes and pockets containing **stagnant** gases, will not profit from atmosphere control. Arrange the tool in the furnace so that all surfaces requiring maximum hardness are continually "washed" with a gentle flow of furnace atmosphere.



Inspirator installed on a gas-fired hardening furnace.

You will find it much easier to control the atmosphere in a gas-fired hardening furnace if you will install an "inspirator" as illustrated ("I") in the accompanying photograph. The adjusting screw on the inspirator can be regulated to give you the desired atmosphere—and after that the temperature of the furnace can be regulated by operating only one valve—without disturbing the atmosphere at all.

Modern oil burners are also available that will give you single valve temperature control—with a predetermined atmosphere.

In this issue of "Heat Treating Helps" we have discussed "Hardening Furnace Atmosphere". In future issues of this magazine we plan to continue the discussion, outlining additional data on considerations such as "Quenching Procedures", and "Torsion Impact Test as a Guide to Better Heat Treating Results".

NEWS TO HEAT TREATERS

(Continued from page 38)

"Induction Brazing and Soldering," by W. E. Benninghoff, Vice President, Ohio Crankshaft Company, Cleveland.

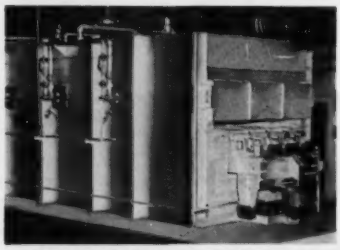
"Sintering and Brazing of Ferrites and Cermets," by R. L. Harper, Executive Vice President, Harper Electric Furnace Corporation, Buffalo.

"Furnace Brazing," by H. M. Webber, General Electric Company, Shelbyville, Indiana.

Also of current interest to our readers will be the panel discussion on Titanium to be held on Thursday, March 28th at 2 p.m. Heat treatment will be discussed and represented on the panel by L. S. Busch, director of research, Mallory-Sharon Titanium Corp., Niles, Ohio.

WALKING BEAM FURNACE

A new Sunbeam Stewart Walking Beam Furnace recently introduced by the Sunbeam Corporation, Chicago, Ill. features a new non-alloy construction to offer low initial cost with minimum maintenance costs.



The basic design of the furnace is said to make it more suited for high temperature forging operations as well as heat treating, annealing, etc. Simple water-cooled I-Beams with special refractory piers eliminate alloy walking beams, beam warpage, fatigue, operating jams, and expensive hard-to-get alloy parts. A single drive operates the reciprocation of the four refractory beams and features a mechanical linkage between the charge and discharge ends to provide a smooth and continuous motion. Air cylinders beneath the walking beam assembly reduce horsepower required and provide a snubbing action on the beam members to assure a smoothness of movement.

For further information circle No. 6

MAGNETOSTRICTION TRANSDUCER

What is said to be the first high-power magnetostriction type transducer, Model AM-203B, introduced by Acoustica Associates, Inc., of Glenwood Landing, L. I., New York, for large scale ultrasonic cleaning, degreasing, descaling, plating and other metalworking

and finishing operations is now available to industry. The trans-

ducer is used with mating stainless steel jar or is externally mounted on a tank or trough. Only the Teflon face, which is impervious to solvents, most strong acids and alkalis, and other corrosive solutions is in contact with solution. Average rf power applied to the transducer is 66 watts/sq. in. of radiating area. This tremendous power produces cavitation effects throughout a large volume of solution, the useful irradiated volume depending on solution viscosity and temperature, as well as desired rate of production. Special fittings may be mounted on the transducer.

For further information circle No. 7

HEAT RESISTANT PAINT

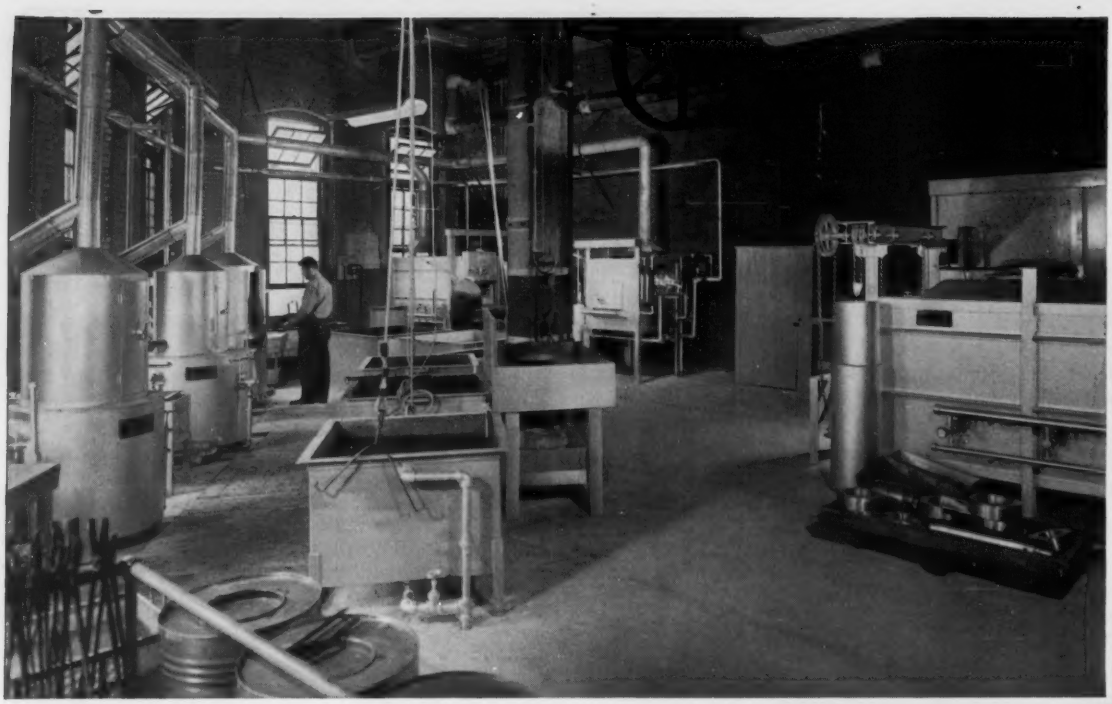
A new quick-drying heat resistant paint for use on surfaces subjected to temperatures up to 600° F. is announced by Speco, Inc., Cleveland.

Known as Heat-Rem QD Black, it air dries to a tough, bright finish in less than 2 hours. According to the manufacturer, QD resists extreme temperature variations, smoke, moisture, fumes, mild industrial acids and alkalis. It is recommended for protecting steam lines, vats, separators, exhaust manifolds, stacks, tanks, ovens and heat lines.

Applied by either brush or spray, QD covers 500 sq. ft. per gallon.

For further information circle No. 8

(Continued on page 45)



It paid them to buy it all from Surface

These Connecticut heat treaters got more than they paid for when they equipped their whole shop with Surface equipment.

The Surface line gave them the greatest range of types and sizes to choose from. Rated production for every item enabled them to know exactly what each furnace would produce in a given time. They could predict what the fuel consumption would be, right down to the cubic foot.

They also gained the advantages of Surface standardization for quantity production: engineering costs are spread over many units, and delivery is quick.

They saved money and time by having only one order, one invoice, one check. They saved costly confusion by centralizing responsibility for delivery, installation, and service.

Surface Combustion Corporation, 2381 Dorr Street, Toledo 1, Ohio.

Send for Bulletin SC-175 on Standard Rated Furnaces—
profit-making products from the thousand-choice heating line

Surface®
HEAT TREATING EQUIPMENT

oven furnaces • forge furnaces • atmosphere furnaces • pot furnaces • convection furnaces • continuous furnaces • atmosphere generators • metal melting furnaces • air heaters • burners

ABSTRACTS

TRANSFORMATION DIAGRAMS FOR CARBURIZED NICKEL-MOLYBDENUM STEELS

Isothermal transformation diagrams, also known as S-curves or T-T-T curves, are useful as a guide to heat treatment procedures for steels. They indicate how rapidly a given steel must be cooled in the quenching operation to insure full hardening without transformation of austenite at temperatures above the range of martensite formation. This information, along with a knowledge of the cooling rates in different sizes in different quenching media, facilitates the selection of optimum quenching conditions. It is useful in determining proper treatments for softening steels prior to machining or cold forming.

The four diagrams are from a recent paper published in *Metallurgia* (London) by G. Mayer and R. H. Hickey, of the Mond Nickel Company, Ltd., Development and Research Department. They portray the transformation characteristics of a series of 2% nickel, .25% molybdenum steels corresponding roughly to the A.I.S.I. 4600 series, with carbon contents of 0.16, 0.29, 0.55, and 0.84% respectively. They were all quenched from 865°C (1590°F) and austenitized for 30 minutes at 770°C (1420°F). Transformations shown are representative of equivalent carbon zones from core to case of a carburized steel.

These diagrams show that the progressive increase in carbon content from the core to the case of this steel results in (a) greater stability of the undercooled austenite and therefore longer incubation periods in both pearlite and bainite ranges; (b) earlier completion of the reaction in the pearlite range; and (c) later completion of reaction in the bainite range.

"Inco Nickel Topics" Vol. 9, No. 10, 1956

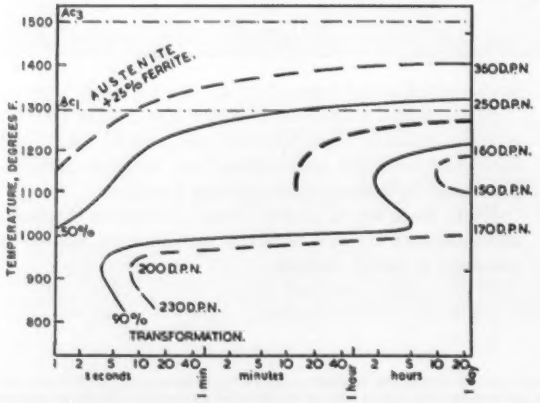


Fig. 1.—0.16% C, 2% Ni-Mo steel, refined from 1590°F and austenitized 30 minutes at 1420°F.

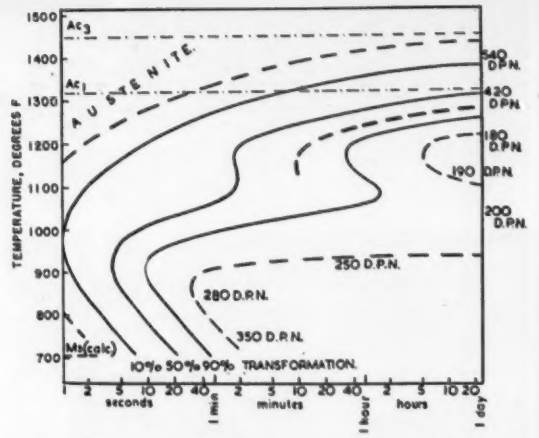


Fig. 2.—0.29% C, 2% Ni-Mo Steel, same treatment as Fig. 1.

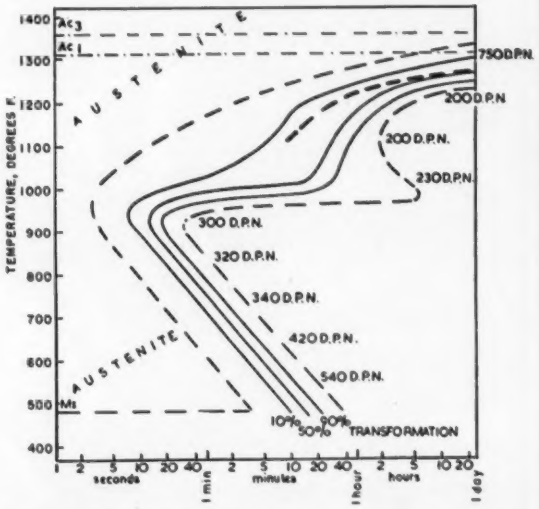


Fig. 3.—0.55% C, 2% Ni-Mo steel.

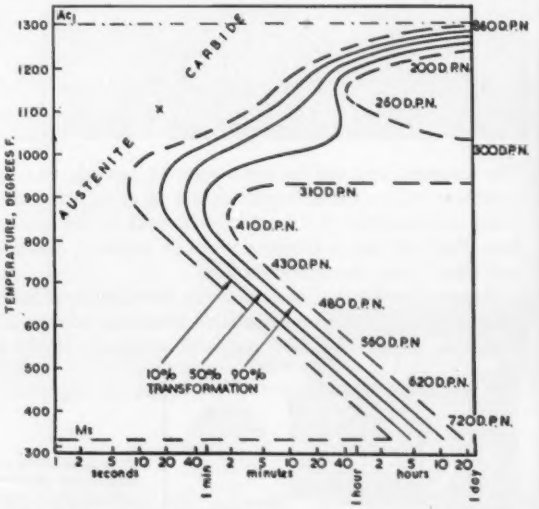
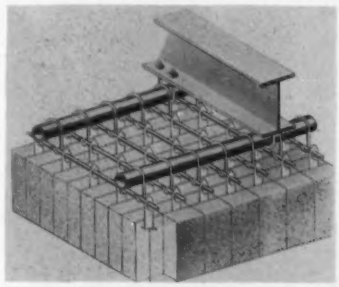


Fig. 4.—0.84% C, 2% Ni-Mo steel.

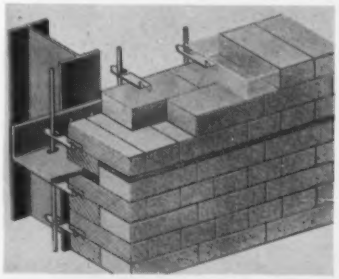
(*Continued from page 41*)

SUSPENDED INSULATING REFRACTORY WALLS AND ARCHES

Prior to a new development by the Geo. P. Reintjes Company the suspending of insulating wall and arch tiles had been complicated because very few manufacturers were able to make tile shapes. Most refractory companies form and burn "Biscuits." The desired brick shape is then sawed or ground from these biscuits. The maximum size of the tiles that most factories can grind from the biscuits is 3" x 4½" x 9".



The suspended insulating refractory arch which has been developed by the Reintjes Company employs a method of using a stainless steel supporting clip, one end of which is impaled between a pair of brick. The other end of this support is so designed as to hang over a rod much the same as clothes are hung on a line.



The opposing faces of the bricks are dipped in air-setting high temperature bonding cement before impaling the clips and then hung in pairs on pre-spaced rods. The clips extend beyond the refractories and are of sufficient length so that insulation of suitable thickness can be applied. The supporting rods in turn are supported from tubing on approximately 18" centers.

The suspended insulating refractory walls are similarly supported. The bottom row of tiles rests on the horizontal leg of an angle which has been previously attached to the vertical column. Rods at suitable intervals are fastened to these angles. The wall tiles are then laid in a manner similar to the building of gravity walls.

Stainless steel anchoring supports are hooked over the rods and their inner ends impaled in the brick. The sectional suspending of the wall is accomplished by spacing the supporting angles 2 to 4' apart, and having offset expansion joints occurring at the support angles.

With this design the vertical supports, with exception of the impaled stainless steel anchors, are located outside of and spaced away from the refractories.

Insulation, either plastic or block, can be readily applied to the outside of the wall.

By using 3" brick, standard insulation blocks of 6" width can be installed without cutting. This applies to both the Wall and Arch described above.

For further information circle No. 9

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

HIGH VACUUM FURNACES

A new 8-page catalog describes and illustrates High Vacuum Equipment Corporation's vacuum furnaces for melting, heat treating, sintering, annealing, brazing, degassing, and purification of metals and alloys. Features of the processes are explained, pointing out the fact that such properties as ductility, cold working characteristics, machinability, fatigue resistance, resilience, temperature resistance, performance life, abrasion resistance, and corrosion resistance can be increased remarkably through vacuum melting and vacuum treating.

For further information circle No. 10

TITANIUM ALLOY HEAT TREATMENT

A new book: "Physical Metallurgy and Heat Treatment of Titanium Alloys", defining titanium alloy heat treatment and recommended practices, has been published by Mallory-Sharon Titanium Corporation, Niles, Ohio. Copies are available from the company at a price of $1 each.

Data reported in the book is based on an extensive investigation carried out under Navy contract at the Mallory-Sharon Research Laboratory. Detailed information on hardening and annealing and 32 illustrations and ten tables are included.

Titanium technology has progressed to the point where alloys can be shipped in a soft, ductile condition, and subsequently heat treated to high strengths. This permits easy machining and forming, yet enables the fabricator to realize the exceptionally high heat treated strength and other advantages.

For further information circle No. 11

INDUCTION HEATING EQUIPMENT

Induction heating is available in many forms for heat treating, annealing, brazing, and melting. A new, colored, illustrated 8-page bulletin published by the Magnethermic Corporation, Youngstown, Ohio, describes the company's low frequency as well as high frequency equipment.

Three valuable charts appear in the bulletin which aid in determining suitable frequencies for various applications of heating. One table indicates the most economic overall equipment for varying capacities and varying diameters of steel bars for forging; one chart indicates the high frequency equipment to be used for various hardening applications; and another chart indicates minimum diameters at which 60-cycle equipment is normally applied for various metals.

For further information circle No. 12

CONTROLLED ATMOSPHERE ROTARY FURNACE

A new 4-page illustrated folder has been published by the American Gas Furnace Company, Elizabeth, New Jersey describing a new model of a controlled atmosphere continuous rotary retort furnace. It has a heat treating capacity of from 150 to 400 pounds per hour, and ferrous or non-ferrous parts may be processed at temperatures from 600°F to 1850°F.

For further information circle No. 13

TEMPERATURE CONTROL ARTICLES

General Electric Company, Schenectady, New York, has recently published a 21-page, illustrated booklet consisting of a series of six articles by R. M. Sills, of the General Electric Company's Industrial Heating Department. Discussed are basic temperature control systems, thermocouples and control instruments, control elements, and special control systems.

For further information circle No. 14

COATINGS CATALOG

"Stop Costly Metal Destruction" is the title of a new four-page illustrated catalog published by the Markal Company, Chicago. Complete information is included on the company's line of "Markal Heat-Proof Protective Coatings," designed to protect metals from scaling and corrosion at temperatures as high as 2100°F; for carburization and decarburization control during heat treating; protection against acids, alkali, salt spray and severe weather conditions. Four basic coating types are described, along with data on possible application, methods of applying and temperature ranges.

For further information circle No. 15

ANALYZERS FOR FURNACE ATMOSPHERES

A discussion of the application of L&N Infrared equipment to monitor CO, CO_2 or CH_4 content of metallurgical atmospheres is now available in a new folder published by Leeds & Northrup Company, Philadelphia, Pa.

The publication describes continuous measurement of these gas components from the output of endothermic or exothermic generators or in the furnace itself. Illustrations of typical chart records are shown as well as schematic diagrams of typical applications and a description of the equipment.

For further information circle No. 16

MECHANIZED HEAT TREATING

A new bulletin published by Surface Combustion Corp., Toledo, Ohio, explains the economic features of completely mechanized heat treat lines.

Twenty-four basic furnace mechanisms are shown with isometric drawings. Photos and diagrams illustrate the steps to be used in building automated lines to insure better end product quality with absolute accuracy.

For further information circle No. 17

DRY ACID SALT

A new dry powder material that replaces liquid muriatic and sulphuric acid is fully described in a two-page usage and instruction sheet prepared by MacDermid Incorporated, Waterbury, Connecticut. Named Metex Acid Salt M-629, this new dry acid replacement salt is packed and shipped in fiber drums. It is used in solution for acid dipping and pickling ferrous and non-ferrous base metals, and for removing heat treat scale.

For further information circle No. 18

JOHNSON GAS APPLIANCE CATALOG

The Johnson Gas Appliance Company of Cedar Rapids, Iowa, has published a new catalog of their products. The catalog pictures and describes Johnson's line of Furnaces, Burners, Valves, Torches, Mixers, Blowers, Stock Tank Heaters and Controls. Complete specifications and shipping weights are listed for each item.

According to the Johnson Company, the new catalog was prepared to bring the trade and their customers up to date on recent changes in the line. A few items have been eliminated, specifications have been altered on others.

The Johnson Gas Appliance Company was established in 1901 and is recognized as one of the pioneers in the development and manufacture of gas burning equipment.

For further information circle No. 19

CARBURIZING OF TRUCK PARTS

(Continued from page 10)

furnace atmosphere change of approximately 1.3 times per hour.

These furnaces are operated in different cycles, according to one of three specified case depths on the parts: 0.025 to 0.035 in.; 0.031 to 0.047 in.; or 0.047 to 0.063 in. The close control maintained in the new setup results in a concentration of carbon which is considered optimum for hardness of structure—thus better load carrying and wearing characteristics on the final parts are obtained. Because of the limitations of the former method, the surface carbon concentration was held in the range of 1.10 to 1.20 per cent on all types of carburized parts. As a result of an extensive investigation, the new furnaces are arranged so that the surface carbon concentration is between 0.85 and 0.95 per cent.

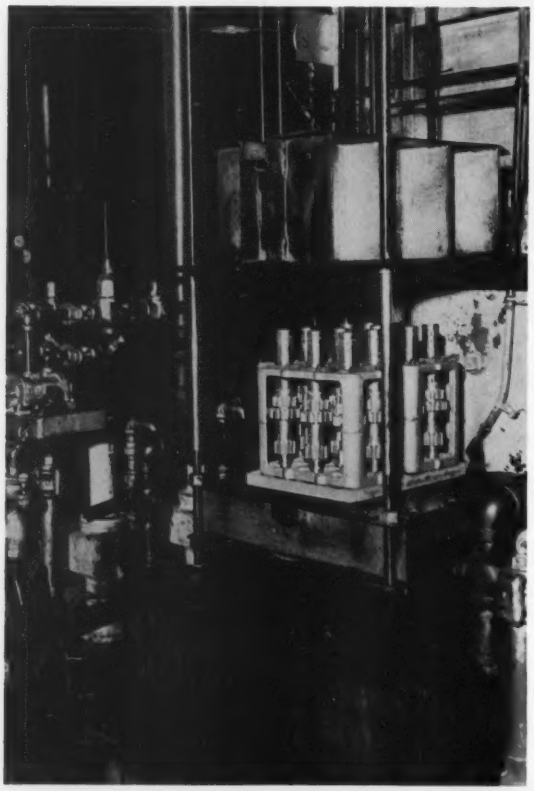


Fig. 3—Tray of transmission countershafts ready to enter the marquenching bath. This part was formerly individually quenched.

The all-important quenching operation is accomplished in a 1600 gallon-capacity quench tank of special design, located at the side discharge door of each furnace, so that the material discharged onto the elevator (Fig. 3) is submerged in the 400 F oil. The tank is designed so that the flow of oil is greatest at the submerged level. The timing of the quench begins immediately after the work is on the elevator. An interesting feature of this setup is that the furnace atmosphere is carried right over the quench tank so that the parts are not exposed to air before quenching.

Fig. 4—Cast high alloy (type HT) trays used to support gears in the carburizing furnaces are of a rigid but lightweight design.

As a result of this marquenching operation, combined with the close control of carbon concentration through careful furnace operation, a fine martensitic case structure is obtained on the gears. One typical gear is made from a steel with the following analysis: Carbon 0.21%, manganese 0.76%, nickel 3.45%, chromium 0.08%, silicon 0.23% and molybdenum 0.25%—corresponding approximately to an SAE 4820 steel. By this method, the following hardnesses were achieved on various portions of the gear teeth: On the surface of the teeth—Rockwell C 60.5; core hardness at the pitch line—C 43; core hardness at the root line—C 38; and core hardness ⅛ inch below the root—C 38.

Because gears are now produced with a minimum residual stress, service life has increased 100 to 200 per cent, compared with gears produced by the former method. Load-carrying capacity, as determined by dynamometer tests, has been increased by 15 to 20 per cent. As a result of elimination of distortion, tangible production benefits have been realized. For example, in one transmission with 13 carburized parts, five parts were formerly press quenched, five plug quenched, one individually quenched, and two batch quenched. Now these parts are all batch quenched with tolerances within desired limits.

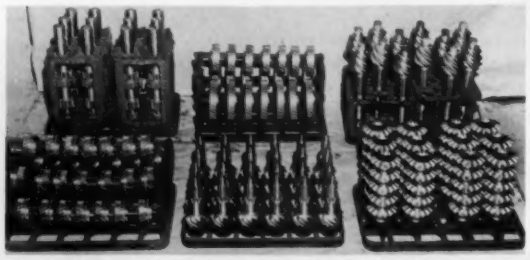


Fig. 5—Typical loading of gears on fixtures, and fixtures on trays prior to gas carburizing. Fixtures and trays are made of HT cast high alloy.

The following advantages of the change in quenching method are summarized by the plant heat treating engineers: (1) Elimination of quenching dies; (2) elimination of plugs for splined bores; (3) elimination of individual handling; (4) greater alloy life; (5) increased load-carrying capacity and longer life of gears due to less residual stress; (6) increased production.

High Alloy Trays and Furnace Parts

A great deal of the success of the new carburizing and marquenching treatments is due to extensive use of specially designed high alloy trays and furnace parts, which withstand the severe conditions of temperature, atmosphere and thermal shock. Trays used to support the gears in the carburizing furnaces are made of type HT cast alloy (35% Ni, 15% Cr). These trays are of a rigid but lightweight design (Fig. 4) since the loading in these furnaces is quite heavy due to the additional weight of special alloy fixtures on which the gears are placed. Thus this special lightweight design compensates for the extra weight of the fixtures. These alloy trays must withstand the carburizing atmosphere, as well as the elevated temperatures in all three zones of the furnaces, which vary from about 1650 to 1700 F. More important, from the point of view of the tray life—because the trays go through the quenching tank with the work—the castings must resist the drastic thermal shock involved in reheating and quenching.

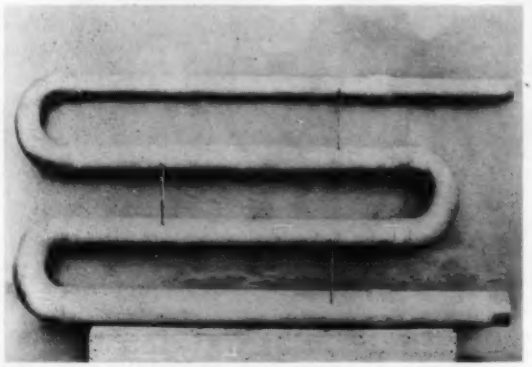


Fig. 6—Radiant tubes, made of type HT alloy castings, are used in heating the gas carburizing furnace.

Loading fixtures on which gears are placed prior to the carburizing operation (Fig. 5) are also made of high alloy castings. These special fixtures enable the gears to be loaded in a horizontal plane, which is a great advantage in obtaining uniform properties. For larger pieces such as first speed transmission gears, typical loading would be 24 pieces on a fixture; for smaller gears, 36 pieces would be loaded at one time.

A great number of important functional parts of the carburizing furnaces are also made of type HT castings. Perhaps most important of these parts are the radiant tubes (Fig. 6) used to heat the furnaces. The following internal parts of the gas carburizing furnaces are also made of type HT cast alloy: Hearth plates, rails, bracket keys, pushover head, fan inlet arch casting, wedges, tube supports, tube brackets, guides, plates, pier caps, rail keys, elevators (inside furnace), arch thrust casting.

The HT alloy composition (33-37% Ni, 13-17% Cr, 0.35-0.75% C) is chosen because of its excellent resistance to gas carburization. Containing up to 1.25% silicon for increased resistance to carburization, this type operates satisfactorily at temperatures up to 2100 F in oxidizing atmospheres and up to 2000 F in reducing atmospheres. As in all high nickel types the alloy is fully austenitic, and this grade is notable for excellent hot strength.

In contrast to the rigid trays used in the carburizing furnaces, other high alloy trays, made of type HT cast alloy, are noteworthy because of their special hinged design. Before carburizing, forged blanks are loaded on these hinged high alloy trays, and sent through a cycle-anneal furnace for grain refining, to allow machining. In this furnace, temperature at the rails is about 1725 F, and each of 44 trays in the row is loaded with approximately 250 pounds of work. After several years of operation, there is some warping of the rails, and the hinged trays accommodate this warping, thus preventing any parts from falling off or the imposition of excessive stresses on the trays. ■■■

"I'LL BE A BIT LATE, DEAR!-HAVING A LITTLE TROUBLE WITH A SUB-ZERO TREATMENT!"

METAL TREATING

EQUIPMENT and MATERIALS DIRECTORY

CLEANING EQUIPMENT

PANGBORN CORPORATION
Hagerstown, Maryland

WHEELABRATOR CORPORATION
Mishawaka, Indiana

★ ★ ★

FABRICATION
(Heat & Corrosion Resistant)

THE PRESSED STEEL COMPANY
Wilkes-Barre, Pennsylvania

ROLOCK, INC.
1232 Kings Highway
Fairfield, Connecticut

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

★ ★ ★

FIXTURES

GENERAL ALLOYS COMPANY
367-405 West First Street
Boston 27, Massachusetts

INTERNATIONAL NICKEL CO., INC.
67 Wall Street
New York 5, New York

MISCO FABRICATORS, INC.
1999 Guoin Street
Detroit 7, Michigan

THE PRESSED STEEL COMPANY
Wilkes-Barre, Pennsylvania

ROLOCK INC.
1232 Kings Highway
Fairfield, Connecticut

STANWOOD CORP.
4825 West Cortland Street
Chicago 39, Illinois

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

★ ★ ★

FLAME HARDENING

OHIO CRANKSHAFT COMPANY
4620 East Seventy-first
Cleveland, Ohio

★ ★ ★

FURNACES

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

DENVER FIRE CLAY COMPANY
2301 Blake Street
Denver, Colorado

DOW FURNACE COMPANY
12045 Woodbine Avenue
Detroit 28, Michigan

ECLIPSE FUEL ENGINEERING CO.
1018 Buchanan Street
Rockford, Illinois

HEVI DUTY ELECTRIC COMPANY
Milwaukee 1, Wisconsin

HOLCROFT AND COMPANY
6545 Epworth Boulevard
Detroit 10, Michigan

INDUSTRIAL HEATING EQUIPMENT CO.
3570 Fremont Place
Detroit 7, Michigan

JOHNSON GAS APPLIANCE COMPANY
522 East Avenue
Cedar Rapids, Iowa

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

THE SENTRY COMPANY
Foxboro, Massachusetts

SURFACE COMBUSTION CORPORATION
HEAT TREAT DIVISION
Toledo, Ohio

★ ★ ★

FURNACES (Salt Bath)

AJAX ELECTRIC COMPANY
940 Frankford Avenue
Philadelphia 23, Pennsylvania

THE A. F. HOLDEN COMPANY
14341 Schaefer Highway
Detroit 27, Michigan

★ ★ ★

GAS GENERATORS

HEVI DUTY ELECTRIC COMPANY
Milwaukee, Wisconsin

HOLCROFT AND COMPANY
6545 Epworth Boulevard
Detroit 10, Michigan

LINDBERG ENGINEERING CO.
2466 West Hubbard Street
Chicago 12, Illinois

SURFACE COMBUSTION CORPORATION
HEAT TREAT DIVISION
Toledo, Ohio

★ ★ ★

GASES

ALLIED CHEMICAL AND DYE CORP.
NITROGEN DIVISION
40 Rector Street
New York 6, New York

ARMOUR AND COMPANY
AMMONIA DIVISION
1355 West 31st Street
Chicago, Illinois

★ ★ ★

HEATING ELEMENTS
(Non-Metallic)

NORTON COMPANY
Worcester 6, Massachusetts

★ ★ ★

INDUCTION BRAZING

OHIO CRANKSHAFT COMPANY
4620 East Seventy-first
Cleveland, Ohio

★ ★ ★

METAL FINISHING

ARTHUR TICKLE ENGINEERING WORKS, INC.
23 Delevan Street
Brooklyn, New York

★ ★ ★

NITRIDING

UNITED STATES STEEL CORP.
OIL WELL SUPPLY DIVISION
Oil City, Pennsylvania

★ ★ ★

QUENCHING OILS

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

SHELL OIL COMPANY
50 West 50th Street
New York 20, New York

SINCLAIR REFINING COMPANY
600 Fifth Avenue
New York, New York

SUN OIL COMPANY
Industrial Products Department
Philadelphia 3, Pennsylvania

★ ★ ★

REFRACTORIES

DENVER FIRE CLAY COMPANY
2301 Blake Street
Denver, Colorado

NORTON COMPANY
Worcester 6, Massachusetts

★ ★ ★

SALTS

ALLIED CHEMICAL AND DYE CORP.
NITROGEN DIVISION
40 Rector Street
New York 6, New York

AMERICAN CYANAMID COMPANY
METAL CHEMICALS SECTION
30 Rockefeller Plaza
New York 20, New York

THE A. F. HOLDEN CO.
14341 Schaefer Highway
Detroit 27, Michigan

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

★ ★ ★

STRAIGHTENING EQUIPMENT

GENERAL MANUFACTURING COMPANY
6437 Farnsworth
Detroit 11, Michigan

★ ★ ★

SUB-ZERO TREATMENT

CINCINNATI SUB-ZERO PRODUCTS CO.
3932 Reading Road
Cincinnati, Ohio

★ ★ ★

TEMPERATURE CONTROLS

METAL & THERMIT CORP.
100 Park Ave.
New York 17, New York

CLARK INSTRUMENT, INC.
10203 Ford Road
Dearborn, Michigan

★ ★ ★

TESTING EQUIPMENT

STEEL CITY TESTING MACHINES, INC.
8817 Lyndon Avenue
Detroit 38, Michigan

★ ★ ★

TOOL STEELS

BETHLEHEM STEEL COMPANY
Bethlehem, Pennsylvania

THE CARPENTER STEEL COMPANY
Reading, Pennsylvania

CRUCIBLE STEEL COMPANY OF AMERICA
Pittsburgh, Pennsylvania

INDEX TO ADVERTISERS

Advertiser	Page
Ajax Electric Company Agency—The Harry P. Bridge Company	40
Allied Chemical and Dye Corp. (Nitrogen Division) Agency—G. M. Basford Company	43
American Cyanamid Company (Metal Chemicals Section)— Outside Back Cover Agency—Hazard Advertising Company, Inc.	
American Gas Furnace Company Agency—Advent Associates, Inc.	24
Armour & Company (Ammonia Division) Agency—Foote, Cone & Belding	17
Bethlehem Steel Company Agency—Jones & Brakeley, Inc.	11
Carpenter Steel Company Agency—Beaumont, Heller & Sperling, Inc.	39
Cincinnati Sub-Zero Products Agency—Baer, Kemble & Spicer, Inc.	47
Clark Instrument, Inc. Agency—Whipple & Black Advertising	29
Crucible Steel Company of America — Inside Back Cover Agency—G. M. Basford Company	
Denver Fire Clay Company Agency—Mosher, Reimer & Williamson Advertising Agency	30
Eclipse Fuel Engineering Agency—Howard H. Monk & Associates	18
General Alloys Company Agency—Roy Elliott Company	45
General Manufacturing Company Agency—F. B. Hubert Advertising Counselors	18
Hevi Duty Electric Company Agency—Comm, Costigan, Inc.	52
Holcroft & Company Agency—Gray & Kilgore, Inc.	25
Holden Company, The A. F. — Inside Front Cover	
Houghton & Co., E. F. Agency—Beaumont Heller & Sperling, Inc.	35
Industrial Heating Equipment Company	37
International Nickel Company Agency—Marschalk & Pratt	7
Johnson Gas Appliance Company Agency—W. D. Lyon Company	30
Lindberg Engineering Company Agency—Don Colvin & Company, Inc.	22-23
Metal & Thermit Corporation Agency—RAF Advertising, Inc.	50
Metal Treating Institute	26-27
Misco Fabricators, Inc. Agency—L. Charles Lussier, Inc.	50
Norton Company Agency—James Thomas Chirurg Co.	32
Ohio Crankshaft Co., The Agency—Carr Liggett Advertising Inc.	19
Pangborn Corporation Agency—Vansant, Dugdale & Co.	16
Park Chemical Company Agency—Marvin Hahn, Inc.	15
Pressed Steel Company, Inc. Agency—Wilbur A. Myers	50
Rolock, Inc. Agency—The Edward W. Robotham Company	38
Sentry Company, The Agency—George T. Metcalf Company	41
Sinclair Refining Company Agency—Morey, Humm & Warwick, Inc.	13
Stanwood Corporation Agency—Tri-State Advertising Co.	14
Steel City Testing Machines Inc. Agency—Whipple & Black Advertising Company	25
Sun Oil Company Agency—Ruthrauff & Ryan, Inc.	21
Surface Combustion Corp. (Heat Treat. Div.) Agency—Odiorne Industrial Advertising	42
Arthur Tickle Engineering Works Agency—Ritter, Sanford & Price, Inc.	31
United States Steel Corp. (Oil Well Supply Division) Agency—Batten, Barton, Durstine & Osborn	31
Wheelabrator Corporation Agency—The Jaqua Company	36
Wiretex Manufacturing Company, Inc. Agency—Bass & Company, Inc.	29